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LIFE IN A HIMALAYAN VALLEY.

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IV.—Religion.

Both the Jaunsaris and the Tehri-Garhwalis are Hindus, but their religion deviates considerably from orthodox Hinduism. The higher one gets up the Tons Valley, the more marked the deviation becomes, till the local religion almost becomes a faith on its own.

In Jaunsar-Bawar and the lower Tehri-Garhwal villages, the people worship local demi-gods or Deotas, as they are locally called, known by the name of Mahasu. There are several Mahasus and the chief one lives at Hanol village on the banks of the Tons river, this village being more or less the headquarters of the local religion. The village is quite small and is in fact one of the worst in the district as regards condition of the houses, while the temple itself is not very imposing. But the situation has the great advantage of fairly easy accessibility. Being low down it is free from snow throughout the winter and can be reached from the Jaunsar-Bawar and Tehri-Garhwal villages of the Tons Valley, and also from villages of the neighbouring State of Jubbal, and from the Pabar Valley, a main tributary of the Tons, to all of which districts the Mahasus have extended their influence.

Besides the chief Mahasu Deota at Hanol, there is another who tours from village to village, staying in the village temples for longer or shorter periods, according to the invitations he receives, for he does not visit a village unless he is invited. He returns at least once a year to Hanol, where the greater part of the gifts he has collected on his tour are handed over to the priests of the headquarters temple.

There are various legends as to the origin of these Deotas. The most common is that they came from Kashmir, whither they had been sought through much peril and hardship by a man from Jaunsar. Bawar, who had requested the Mahasus to come and drive out a local devil, who had been ravaging the people sorely, till very few were left at all. According to this legend, four Mahasus came, three of whom had some physical disability, possibly resulting from the fight with the devil, whom they succeeded in ousting. One named Basak had a wounded thigh, another named Pibasak had a wounded ear, and the third, Baitha, an injured eye. The fourth named Chalta was quite sound. The three injured Mahasus settled down in fixed temples, which became their permanent abodes, while the fourth was able to move about from village to village. The first two, Basak and Pibasak, are said to have moved off to other parts of Tehri-Garhwal, or to British Garhwal, while Baitha and Chalta remained in Jaunsar-Bawar and the lower part of the Tons Valley. But, on the other hand, it is claimed that all four still remain in Jaunsar-Bawar, and there are four temples at which they are said to reside.

So far as the Tons Valley is concerned, at any rate, only two Mahasus have local influence, the one who remains at Hanol and the other who tours about. This differentiation of duties was probably due to a cunning invention of the original Brahmans who in olden times first introduced the gods into the district. They settled down in a fairly central and prosperous part, where people could come without much difficulty to worship the god, and where there would therefore be a fairly good priestly revenue of offerings. But communications in the district being bad, and the priests wishing to tap the more distant and isolated villages, they conceived the idea of having a travelling god, who could go all round the district, returning now and again to the central base with the gifts he had collected.

One effect of the travelling Deota is that several villages have temples which are unoccupied most of the year, being opened only when the Deota has been requested to visit the village. Some, however, have minor gods of their own, and, in some cases these minor

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25. The simple temple of Osla, the last village up the Tons Valley.
The whole of the superstructure is made of deodar wood, with simple carving in the front.

26. Hanol temple is the headquarters of the local religion.
Here resides the chief Mahasu Deota. The travelling Mahasu and other local gods come at least once a year to this temple, bringing gifts for the chief god.

Photos by E. C. Mobbs.

gods also tour among the local villages, and go once a year to Hanol to pay their respects and give tribute to the head Mahasu.

Occasionally there are temples situated far away from villages in groves of *deodar* trees; on the open mountain side, or in the middle of the forest. The *deodar*, or God's tree, as the name implies, is the Himalayan cedar (*Cedrus deodara*), which forms magnificent forests between 7,000 and 10,000 feet. The graceful beauty of the young trees and the stately magnificence of the old trees, which frequently reach over 200 feet in height, are sufficient explanation of their having been selected by the simple people as their sacred tree, although the value of the timber, the association of the tree with the source of the Ganges and other reasons would also render it sacred.

The best of the temples is probably the one simply known as Deota. This is situated in a charming spot in the middle of some fine *deodar* forest, some five miles from the nearest village. At the bottom of a small precipice about 8,500 feet up in the forest is a small open grassy spot, surrounded by magnificent *deodar* trees, mixed with some almost equally fine spruce and silver fir. Here in the natural opening, set back from the path leading to the site, so as to occupy the most advantageous position, is a fine wooden temple, so old that its origin is unknown. It has the typical temple design—first two ante-chambers, plainly constructed, with simple sloping roof, leading to the main part of the temple, the chamber of the god, which is square and higher than the ante-chambers. The upper part is smaller than the lower part, leaving a sort of gallery which extends on all four sides, the whole being covered by an overlapping conical roof.

As will be seen from the photos, the ornamentation of this temple is particularly good, consisting of wood carvings and strings of wooden balls suspended from the edge of the conical roof. The best carvings are those on the wooden panels of the gallery, some of which represent various gods, while others represent birds, the meaning of which is now unknown. The best form of carving seems now to be a lost art among the local people. A few years ago some of the panels required renewing and fresh ones had to be carved with the same design as

the old. No one was available locally to do the work, and skilled labour had to be brought in from a neighbouring state.

A small spring rises in the grassy opening at Deota, and it is said to have its origin in the centre of the temple itself. In the temple there is a stone tank containing water, in which stands a stone cow, and the stream is supposed to rise from this tank. According to local belief, which is most firmly held, an irreligious man once went inside the temple and tried to measure the depth of the water in the tank with a bamboo stick. He was rewarded for his trouble by falling in the water, and, strange to relate, he emerged again from another spring situated by the Tons river some 5,000 feet lower down! The spring rises in the forest vegetable garden at Thadiar, and more than one person has solemnly assured me that the man emerged at that very place.

The Deota temple is unoccupied most of the year. In winter it is under snow for about four months, but in summer it enjoys a fine climate. It is in summer, therefore, that the god visits his temple, either once, or sometimes twice a year. In the procession that accompanies his arrival there are no large images present, such as the life-size images that have been made of the local Mahasus, but simply a large silver casket, the lid of which has a handle in the centre fashioned like the conical roof of the temple. This is carried on a rough palanquin, borne on the shoulders of the men, the whole being covered with a big sheet, somewhat dirty and the worse for wear.

On one occasion the sheet was removed for my special benefit, but as I was wearing boots, I was not allowed to approach closer than about five yards. One or two peacock feathers, presumably brought from the plains, for peacocks do not occur in these parts, rested on the palanquin, while one of the attendants held a large whisk of white horse hair with a silver handle, which he used to whisk flies and dust off the casket when it was uncovered. Altogether there were about a hundred people accompanying the god, nearly all being men, but a few women. The men vied with each other for the honour of bearing the palanquin on their shoulders, about eight men carrying it at a

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27 and 28. Deota temple is one of the finest of the Tons Valley.
It is situated in a charming spot in the middle of the forest, several miles from the nearest village. On three sides are magnificent deodar, spruce and silver fir trees while on the fourth side rises a small precipice.

Photos by E. C. Mobbs.

time, two for each end of the two poles. Several musicians with trumpets and drums added colour and life and a semblance of order to an otherwise disorderly crowd.

Most of the temples of the Tons Valley are so orientated that their doors face the west, and in summer the setting sun shines straight through the open doors of the ante-chambers to the inner chamber, where the light strikes the image of the god, situated in the centre of the room. In the villages the temples have usually well paved courtyards, which form convenient dancing grounds at festivals.

Cows and bullocks are regarded as sacred animals in accordance with orthodox Hindu custom, and they must on no account be killed. Consequently, one frequently meets lame cattle among the village herds out to graze on the hillsides, and it is pitiful to see them limping up the rough slopes. In one village I came across a cow with a broken leg. It had been unable to move more than a yard or two for over two years! But such animals must not be put out of their misery and must remain as they are till they die.

In Jaunsar-Bawar and the lower part of the Tons Valley, the local religion goes one step further than the dictates of orthodox Hinduism. For the Mahasu Deota has dictated that the people are never to drink cow's milk, and to this day the majority of the people neither drink milk themselves nor supply it to others. The people now believe that if they drink milk it will turn to blood and will do them more harm than good, and on one tour for five months I obtained no fresh milk at all from any of the villages in the district owing to this custom. Milk is sometimes used for making butter, but the Mahasu has again decreed that it is meritorious to abstain from eating butter and more praiseworthy to burn it at the various temples and shrines where the Mahasu is worshipped.

The poor milk-giving qualities of the cows are probably partially the result of these customs, no attention having ever been paid to breeding for milk production. Any idea of selective breeding seems to be entirely absent, and the fact that the cattle are very good hill climbers is just due to natural selection: the grazing grounds are

so steep that in the course of a few generations only good climbers would survive.

Among other decrees that the Mahasu Deota made, was an injunction never to sleep in a bed with four legs, with the result that the people all lie on the floor at night, no beds being used at all. Another decree was that the best goats should be sacrificed at the god's shrine. For this reason goats are frequently presented to the temple priests as an offering to the god, while the killing and eating of sheep and goats at many of the local festivals probably has some religious import. The greatest of the festivals is one held in February, when every household that can afford it kills a sheep or a goat and has a feast, accompanied with night-long dancing. The animal is beheaded with a special axe and the head is cut right off with one clean sweep. Some one stands a little distance in front with an iron dish, ready to catch the blood as it spurts out from the severed neck.

In the upper part of the Tons Valley the influence of Mahasu gradually decreases, till before long he is not acknowledged at all. The people here venerate the cow as true Hindus, but they also drink its milk without fear of Mahasu's anger. Each village or group of villages has its own demi-god and local customs, and each temple has some peculiarity of construction, carving or other ornamentation of its own. Frequently the temple courtyards are enclosed by walls of carefully hewn gneiss rock slabs, arranged in pyramids, the art of making which has now been lost.

The gods of these upper villages claim to hold sway over all the alpine grazing lands. One village god used regularly to take tribute from villagers of the Jumna valley, who annually brought their sheep and goats to the grazing lands of the Upper Tons. On one occasion the visitors refused to pay tribute. The local people thereupon seized some of their animals. The case ultimately came before the High Court of the State, where it was decided that legally, at any rate, although he might accept gifts, the local god had no prescriptive right to levy tribute.

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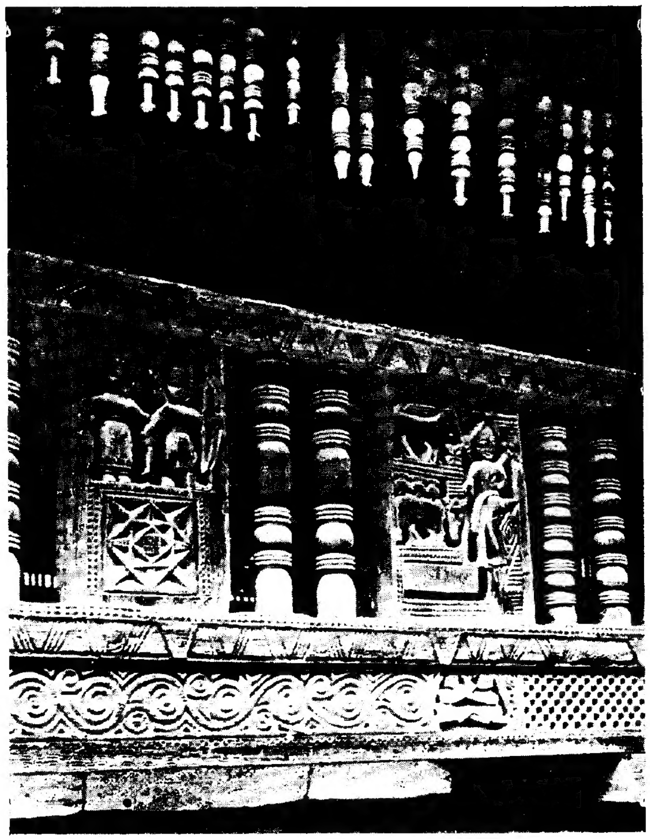

29. Carved wooden panels of Deota temple.

30. A forest shrine to the god of shikar.

This shrine, near the large temple of Deota, contains life size wooden images of the god. Horns and other hunting trophies are offered to the god, while offerings of coins and other articles are nailed to the door posts.

Photos by E. C. Mobbs.

Although the local gods naturally dominate the religious customs, a certain amount of regard is given to the greater Hindu gods and to some of the more general Hindu observances. The great festival of Holi is not observed at all, but on the other hand, the people of the Tons Valley always observe eclipses, having their own local astrologers, who keep themselves acquainted with the calendar and important astronomical events. But local events may take precedence over these general festivals. Thus in one village on the occasion of an eclipse of the moon, an old woman died. So no festival was observed at all, as a mark of respect to the departed spirit.

Besides the temples to the chief local gods, there are certain shrines, some of them erected to special gods, others of a more general nature. Thus at Deota, under the shade of the tallest trees at one corner of the temple ground, there is a small shrine containing two life-size wooden statues of gods, said to be dedicated to the god of shikar. To this shrine small gifts are frequently brought, and they are usually nailed to the doorposts. For the most part they are small coins, buttons and other articles of a like nature, but there are also the horns of a tahr, the Himalayan wild goat, offered possibly by some local shikari, and the last time I went there I found that an old Gillette razor blade had been nailed up. Perhaps some villager had somehow come across a blade that had been thrown away by one of the forest staff, and had nailed it up as an offering, as it was of no use to him, but looked too good to throw away !

Small shrines are sometimes situated above the forest at the edge of the alpine grazing lands, at about 11,000 feet, erected by the few men who take the sheep and goats up there during the summer months. Such shrines, as will be seen in the photo, consist simply of a small stone pillar of small fashioned rocks, enclosing a small stone slab carved with a mystic design, possibly brought from the temple of the village from which the graziers come.

There are certain other sacred spots, especially in the *deodar* forests, characterised by pieces of cloth tied to a tree, or by the nailing up of a coin. Thus in one spot I came quite unexpectedly in

the middle of the forest to a tall *deodar* tree to which a silver four-anna coin had been nailed. Such spots are frequently prominent places where a good view is obtained, or a beautiful glade in the forest, or where there is some unusual natural phenomenon, such as a large rock split with a tree growing between the two halves.

The religious beliefs of the people are mainly those of fear; fear of their gods, lest they become angry, and fear of evil spirits, who are always on the look out for cause to do people harm. Their fear is coupled with their natural conservativeness, and they object to any changes or innovations on the ground that the local god would be displeased. The god can, however, be appeased by the sacrifice of a sheep or a goat. This is always done each year before the commencement of fellings in the *deodar* forests, and is also insisted on before the commencement of such major works as the dismantling and rebuilding of a suspension bridge.

But it is the evil spirits that are most feared. When a man crosses from one valley to another, he frequently throws down a stick or a stone or a pine cone on the top of the pass to prevent the evil spirits of the one valley crossing over with him into the next valley, or as another explanation has it, to keep buried the evil spirit that resides on the pass. On the main pass near Jarmola, between the Tons Valley and the Jumna Valley, there is quite a large mound of sticks, stones and pine cones thrown down in this way.

The most extraordinary case of all that I met was with the people of a village known as Bainol. They had been greatly distressed by several deaths, both among themselves and their children and also among their animals. At the same time they said that their crops had begun to go bad. So it was finally decided that evil spirits had taken possession of the village and it would have to be deserted. The decision having been reached, an immediate evacuation took place. A few necessary clothes, cooking untensils and other articles were hastily collected, and all the people went off to a small *chak* or area of cultivation belonging to the village, situated within the reserved forest. Here there were one or two houses, normally occupied only

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31. A shepherds' shrine.

Villagers taking their sheep and goats to the alpine pastures for the summer months have erected this shrine at the edge of the forest, some 11,000 feet up. It is under snow for nearly six months of the year.

32. A pile of sticks, stones and pine cones on the main pass between the Tons and Jumna Valleys.

When a man crosses from one valley to another, he throws down a stick or a stone or a pine cone to protect himself from evil spirits.

Photos by E. C. Mobbs.

in the agricultural seasons, where some of the people now settled, while the rest made temporary shelters for themselves from grass and the branches of trees. I went over the deserted village soon after and found that the crops had been left as they were, some fields only half-ploughed, others with the young crops coming up, while baskets and agricultural implements were lying about in the fields and other things had been left behind in the houses in the hurried departure of the people.

This was not the end of things, for soon the food supplies ran short, and the people had to sell some of their animals to purchase further supplies. They also realised that fresh cultivation must be established if they were to live. So an official application was sent to me as the forest officer asking for certain areas of reserved forest to be cleared and given for fresh cultivation, and for trees to be granted for the construction of new houses. It is difficult to investigate a trouble put down to evil spirits, but I thought that perhaps some epidemic had caused the deaths, while since the old village lands could not be extended owing to the steep nature of the areas all round, the people were feeling the need of further land for cultivation. On the other hand the site of the village was well chosen, being on the gently sloped top of a ridge, and it should normally be a very healthy spot. At the same time, I wanted to discourage the taking up of fresh forest land to the extent required, as it had taken years of tactful dealing by past forest officers to get the people to settle down and to cease their former migratory habits, destroying the forests as they moved from place to place for the sake of a few years' cultivation.

So I refused to grant any land from the reserved forest and tried to persuade the people to return to their old village. But my arguments did not convince them. The fact that I had been all over the old village lands with my orderly and both of us survived to tell the tale was no proof that the evil spirits were not still there. And my suggestions of a great sacrifice of sheep and goats in accordance with local customs, or of calling holy men to drive away the evil spirits, were ridiculed, as the spirits were too formidable; they had taken possession of the village in real earnest, and the people had no hope of being able to drive them out.

There the matter stood and several months passed since the people had left their village, and conditions were getting serious. I therefore again investigated the case, and this time also considered the forest area that was required as the site for a new village. But it so happened that this area had once been village land: the whole mountain side bore unmistakable signs of old terraces, and there were still a few remains of old houses at the old village site. The village had apparently been abandoned and pine forest had established itself on the old terraces, and there was now a very fine young forest. So in addition to my reluctance to destroy all this good forest, there was now the additional argument that the land required had once been an old village, and what more likely explanation was there than that it had been abandoned because evil spirits had decided to take up residence there. Surely it would be jumping from the frying-pan into the fire for the people to settle down in an area that had already been once abandoned, probably by their own great-grandfathers, since they were the nearest villagers! Perhaps my argument had effect, or there may have been some other reason. At any rate, there the matter rested and, soon after, I was informed that the evil spirits had left the village and the people had decided to return to their old homes on my promising to give them some small areas in the forest for additional cultivation, a reasonable request to which I readily agreed.

Besides the evil spirits, there are other spirits which might be called fairies. I could not quite make out what is the exact relation of the fairies to human beings, but they have at any rate to be respected. It appears that they live mainly in glades in the forest, but they may also visit villages. I came across these in connection with another application for forest land required for cultivation. I went up to the village, one of the last in the Tons Valley, to investigate the existing cultivation and the need for further extension. Near the village I came to an open space which was neither built over nor cultivated. So I suggested that this might be taken up first of all. Oh no! I was earnestly assured by all the elders of the village that this area could on no account be cultivated. It was dedicated to the forest fairies, and to this place the fairies were wont to come at night to play.

I did not press my suggestion for other reasons, and the fairies are probably playing there still!

It was usually beyond my time and vocabulary to attempt much discussion with the people about their beliefs and customs, but occasionally it was possible. One such case was when I went down to the fields of Kalawa village to try to shoot the bears that were damaging the crops. After I had reached the fields and found that all the bears had gone, I sat down with my guide and the man whom we had found sleeping under a rock, and the guide, a young man, began to tell me about the gods and the evil spirits and his fears of both. He was probably drawing considerably on his imagination when he detailed to me his encounters with the spirits. He could not tell me what they looked like and the middle-aged man sat silently with an amused expression. Finally, he interrupted and told me not to believe what the young man had told me. Grasping a handful of earth, he held it up and said, " Sahib, this is our Deota, this earth and the sun!" And he explained his view: the earth and the sun as man's sole source of life, and consequently as man's gods. This was in the upper part of the Tons Valley, away from the influence of the Mahasu Deotas. There the villages are isolated from the rest of the world. The people live next to the great snow mountains and speak of the neighbouring areas of Jaunsar-Bawar and the lower part of the Tons Valley, where the ridges reach only a mere 10,000 feet, as the lowlands. Their lives are simple and their faith is simple. They believe in gods, spirits and fairies, but for all practical purposes their faith is the same as that man's: the earth and the sun are their life and their god.

A VERY EARLY ITALIAN SILVICULTURIST :—P. V. MARO.

By H. P. D.

The credit for being the first to expound the principles of scientific forestry is generally given to the French and the Germans, who still remain its chief exponents. The forest laws of Colbert (1619-83), the enlightened minister of Louis XIV, would seem to establish the priority of the former by a short lead. Actually the Italians were very much

earlier in the field, in research, if not in application. Leonardo da Vinci, when not engrossed in painting enigmatic and jocund ladies, flung his net wide. His researches into science included not only such startlingly modern subjects as aviation, but even forestry. The forests of Amboise, it may be remembered, formed a sort of Kaunli Bagh for his declining years. But even he belongs to comparatively recent history. It is a much farther cry from the fifteenth to the first century, when a certain tireless old savant perished in the lava of Vesuvius. He left voluminous notes on forestry, which, up to the present, have never been edited, scientifically or otherwise. But it is not of him that I want to speak, but of a yet earlier compatriot, who preceded him by nearly a century, and whose contribution to the science of forestry, though by no means so profound, was perhaps of greater intrinsic interest.

This was P. V. Maro, the son of a well-to-do farmer of Mantua, who was born in 70 B.C. Of his early life we know little except that he was exceptionally bright, and was educated in the neighbouring town of Cremona and afterwards at Milan. Perhaps he was a little high-spirited at school, and it may have been dislike of the close parental eye upon his doings that prompted his lament on the proximity of home (*Mantua....nimium vicina Cremonae*).

On his return from Milan to the ancestral seat he seems to have occupied his spare time in literary work, and to have taken readily to the pleasures of rustic life, so that the old folk must have been spared much anxiety as to how to keep him down on the farm after he'd seen....Milan. But at one time their hopes seemed to be rudely shattered.

The Italians are naturally a sportive race. Not only in recent years, but all down the ages, they have been prone to "racketing." The first century B.C. was no exception. But then there was no trans-atlantic outlet for their gunmen, nor had Chicago yet been perpetrated, so that the Al Capones of the day had to amuse themselves as best they could in their own and the adjacent countries.

The history of this period in Italy is not without a certain interest. Full records area vailable and can be studied by the curious.

The domestic differences of the two leading gangsters of the day—father and son-in-law, respectively, make striking reading. The vendetta convulsed the land from coast-to-coast for nearly a decade, and overflowed into the Levant, leaving a trail of chaos and bloodshed. During this time many had their lands annexed by the triumphant faction, and Maro found himself among these unfortunates. Eventually both protagonists were bumped off by their opponents, one in Egypt and the other in the streets of Rome, and order was restored under a sort of Fascist movement, complete with Dictator.

The facile pen of Maro had already attracted notice, and he soon managed, by judicious eulogies of the new regime, to insinuate himself into the good graces of il Duce and wangle the return of his property. He did more: he wangled himself a good appointment.

The importance of a "good press" has been realised by political leaders of all nations and epochs, even the most ancient, and at this time a back-to-the-land campaign, to make the world safe for autocracy, needed boosting, and talented young writers were in demand.

Maro got in, so to speak, on the ground floor. He was commissioned to write a series of propagandist pamphlets glorifying the virtues of country-life under different aspects: farming, stock raising, bee-keeping, forestry.

It is with the last of his treatises that I wish to deal. From readers of scientific journals a certain amount of indulgence must be asked for consideration of a work so devoid of scientific method and detachment. Yet remembering the remoteness of his age we may perhaps excuse his imperfections in the light of Dr. Johnson's famous remark about performing dogs, that it is less remarkable that they perform well than that they perform at all.

He wrote, of course, in the barbarous dialect of his day. To us familiar with the mellifluous accents of the modern tongue—on the Cracovia perhaps, or Aquileia—the archaic Italian of the first century will sound incredibly crude and harsh. Nevertheless it had its uses. As a punitive instrument it was unrivalled, and survived within living memory in seminaries for the young.

The monograph commences with a note on natural regeneration (*nullis hominum cogentibus ipsi sponte sua veniunt*) and enumerates various invasive species, such as osier, poplar, broom and willow, which reproduce themselves easily. Others, the writer says, are better propagated artificially (*posito de semine surgunt*), such as chestnut, oak, aesculus, etc.; while certain, such as elm, cherry and bay, may be grown successfully from root-suckers.

He goes on to describe the different ways of planting. First there is the ordinary method with seedlings. If rooted stems are not required, slips may be taken from the parent tree, and when this is done, the leading shoot (*summum cacumen*) will be found to give most certain results. But even dry sections of the trunk have, on occasion, been known to sprout. Layering is also mentioned, and there is a somewhat obscure reference to what may have been our method of stump planting.

Hic stirpes obruit arvo.
Quadrifidasque sudes et acuto robure vallos.

"Obruit" would seem to imply burial, and possibly refers to the planting of roots or rhizomes. "Sudes" and "vallos" probably indicate large and small stumps respectively, which have been squared (*Quadrifidas*) and pointed (*acuto robure*) to expose as much of the cambium layer as possible.

Then follow some interesting remarks on fruit trees, showing how by cultivation the wild varieties have "doffed their jungly habits" (*exuerit silvestrem animam*); and advising vegetative reproduction as more certain than by seed.

We moderns have little cause to plume ourselves on our advances in the art of grafting. It seems to have been a speciality of the ancients. Even the combination of fundamentally dissimilar families does not cause them any difficulty. Crossing of apple and pear we might perhaps credit—we have our Loganberries—but what are we to make of their grafting of rosaceous plum upon umbelliferous cornel, or the monstrous union of walnut and arbutus? But when we read of apples borne on plane trees and chestnuts upon beech, we

begin to have our suspicions, which ripen to a certainty at his audacious picture of the swine crunching acorns under the parent elm. The imperial leg seems to have been well and truly pulled, and the puller got away with his hoax down the centuries.

Budding he correctly distinguishes from grafting, and describes the technique of each, which does not differ much from modern practice. His next theme is the differentiation of the various species. To tell them all would be as hard, he says, as counting the Ionian waves or Libyan sands. And just to indicate the magnitude of the task, he goes through the motions of enumerating a list of sonorous names.

And now we come, in the approved text-book manner, to the "factors of the locality." Not all sites, we learn, suit all species. Willows grow by water, alders in fens, yews on northern aspects, rowans on mountain slopes. Nor is racial distribution confined to human beings. Trees have their special habitats (*divisae arboribus patriae*). India alone, for instance, produces black ebony. Incense-bearing boughs are found exclusively in Saba (South Arabia)—evidently the writer was excusably ignorant of the wider distribution of *Boswellia*.—He recalls the groves of Ethiopia that bear wool (probably kapok from *Bomlax* or *Erythrina*) and the silk " combed from leaves by the Seres (Chinese) " which no doubt refers to mulberry.

The next remarks are of such peculiar interest to Indian foresters that I may be excused for quoting them in full :—

Quid tibi referam

* * * * * *

Aut quos Oceano proprior gerit India lucos.
Extremam sinus orbis ? ubi aera vincere summum
Arboris haud ullae jactu potuere sagittae.
Et gens illa quidem sumptis non tarda sagittis.

Here we have an unmistakable picture of the tropical evergreen formation, the immense " rais " or " sholas " of the Western Ghats, so tall that even the practised bowmen of those parts cannot reach

their tops with their arrows. Such forests lie " close to the ocean " in Kanara, and would impress the ancient mariners of Italy who touched on those shores.

There seems little doubt that the "felicitous apple " of the Medes, whose juice is tart and savour clinging, refers to some variety of citron—probably our old friend the " nimbu," if indeed we can, which I doubt, ascribe any efficacy to the latter in " averting the fell designs of poisoning stepmothers." The efforts of the writer to describe the tree are rather naive. " Itself it is a huge tree, most like in appearance to a laurel ; in fact, if it did not emit a different odour it would be a laurel. Its leaves fall in no wind, its flower is most tenacious. The Medes scent their breath and lips with it and administer it to asthmatic old men."

The next section indicates that the importance of the tourist industry was as well realised in the ancient world as in the new. The new regime was anxious to reassure the world that the rumours of the recent atrocities had been greatly exaggerated. The panegyric of the attractions of Italy which has been inserted by the author, more or less irrelevantly, could hardly have been bettered by the present Fascist travel agencies. It could give points even to Intourist. It must no doubt have been very comforting to prospective travellers to know of the absence of fire-breathing bulls, truculent warriors, ravening tigers, savage lions and poisonous herbs. These are just if somewhat negative pretensions. But to deny the existence of snakes in a climate like that of Italy is rather disingenuous. But what of this . . .

" Here blooms perpetual spring, and summer here
In months that are not summer's ; twice team the flocks
Twice does the tree yield service of her fruit ? "

That this description is somewhat idealistic would not be denied by anyone who has had the misfortune to visit Naples (say) in July or Milan in January.

Soils are next described, and tests of texture given. A damned (sceleratum) cold soil is only fit for spruce and yew. The epithet sounds as though he spoke from bitter experience. Nurseries should be

made only on kindred soil close to the intended plantation. This is familiar stuff. But it is a rather novel suggestion that the north side should be marked on the stem of nursery seedlings to ensure their correct orientation in planting out. Habit, says Maro, is of prime importance in early youth.

The effects of close and symmetrical planting were fully appreciated by the ancients.

" Not otherwise will earth afford.
Vigour to all alike, nor yet the boughs
Have power to stretch them into open space."

They also knew how to manure, and to modify the texture of the soil by mixing porous stones and shells.

Maro has a few trenchant remarks to make on the damage done by grazing in plantations which would be endorsed by every forest officer. Especially is he intolerant of goats. He asserts the old belief that their saliva has a toxic effect on vegetation. This is the reason, he says, why the goat was always sacrificed to Bacchus.

Maro found a keen delight in the sight of forest crops which owed nothing to the hand of man.

juvat arva videre
Non rastris hominum, non ulli obnoxia curae.

We, as foresters, however, while we admit there is a certain glamour in a virgin forest, cannot endorse his preference for the wild. To us the liveliest satisfaction is afforded by the contemplation of a forest subject to scientific tending, say a normal series of age classes, if there be such a thing, or the effects of an ideal improvement marking.

His treatment of Utilisation in the latter part of his treatise is almost reminiscent of parts of Schlich Volume V. The examples of the uses of the common European species which he gives remain substantially unchanged to the present day.

For the last hundred stanzas our author discourses sententiously, and as his observations, though graceful and profound, have no immediate bearing on forestry, I think it a suitable occasion, in the words of his closing line, to " Loose the sweating horses from the yoke."

F. R. I. PORTABLE CHARCOAL KILN.

BY S. RAMASWAMI.

General.

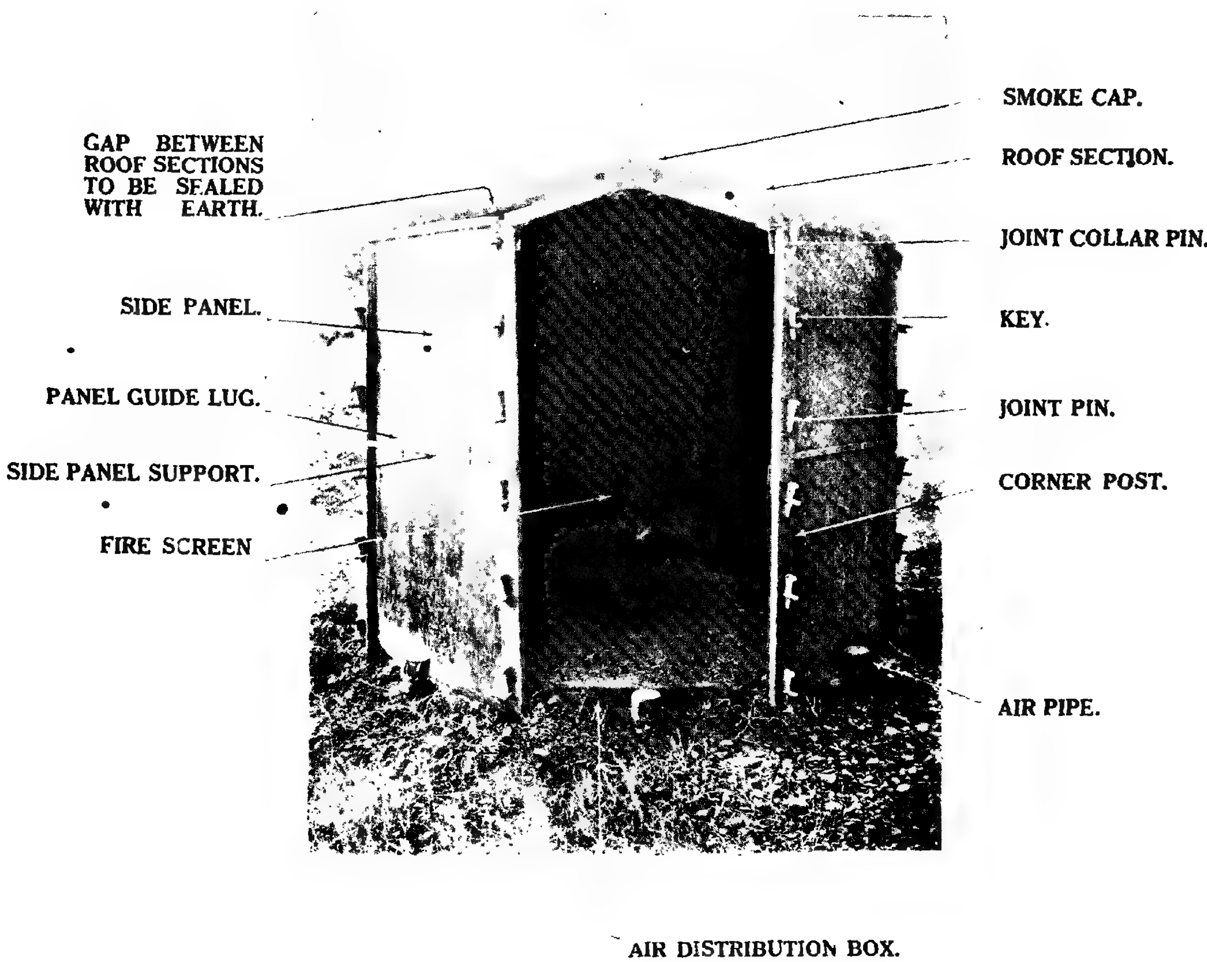
Large quantities of charcoal, are sold annually in every town and city in India, but the supply is at present sometimes limited and not always equal to the demand. Moreover, charcoal burning is carried on in most districts only during a few months of the year, as forests are closed to charcoal burning during the hot dry weather on account of fire hazard, and is impossible by the usual "country" methods during the monsoon. The need for improved methods of charcoal production is, therefore, obvious.

The introduction of portable charcoal kilns seemed to offer the best solution to this problem, and in 1928 two kilns of French manufacture were obtained by the Forest Research Institute, Dehra Dun, for experimental purposes, and were given extended trials in several Indian forests as well as in the grounds of the Forest Research Institute itself. The results of these trials were published in the *Indian Forester* of August 1931, pages 393—403.

As the result of the valuable experience gained, it was decided that though these French kilns were quite satisfactory so far as their working was concerned, their high initial cost was a very great drawback, especially in India, where the charcoal contractor is generally a man of slender means and one who cannot afford large capital expenditure on the purchase of kilns. It was also found that the component parts of these imported kilns were too heavy for easy transport in hilly districts by coolies. In order to remedy these defects an attempt was made to manufacture a kiln completely suited to Indian conditions.

The "Frikiln," as the new kiln is called, was entirely designed by and made at the Forest Research Institute, Dehra Dun. Its component parts were all made from standard materials readily available in Indian markets, and no part is too heavy to be readily carried by a cooly. In addition, the whole construction of the kiln was made

F. R. I. PORTABLE CHARCOAL KILN.



as simple as possible, so as to encourage construction by local *mistries*. The kiln was first given a thorough testing and such alterations as seemed advisable were made. It was then tested again till its working was completely satisfactory.

Scale drawings of the kiln were then made and sent to various firms of manufacturers in India, and quotations for its manufacture were invited. The lowest quotation was received from a Bombay firm* who said they were prepared to manufacture the kiln for Rs. 535 each F. O. R. Bombay, for an order of not less than twelve at a time. This figure is considered to be on the high side and those interested in the kiln would probably do better by having their kilns constructed locally. There is nothing difficult about the construction and a good blacksmith able to read mechanical drawings should be able to make the kiln for less than the amount quoted.

The "Frikiln," as shown in the accompanying photograph consists of eight side panels (each of which is divided horizontally into two equal parts). The roof also is divided in the same way into eight segments corresponding to the side panels. The bottom halves of the side panels are subjected to intense heat and are, therefore, protected on the inner side by a fire screen, with an air space between the panel and the screen. The buckling of the lower panels from overheating is thereby avoided. The panels are joined together by means of U-bars, bolts, and wedges, and the hollow spaces at all joints are filled with dry sieved earth. This gives a completely air-tight joint. The roof is composed of eight segments supported on a collar at the centre which is itself supported on eight radial members fixed to bolts on the top of the eight side channel-irons or U-bars. The joints between the side panels and the roof segments, and also those between the roof segments themselves, are made air-tight by packing with dry earth, a simple but very satisfactory method of obtaining air-tight joints. Air enters the kiln through L-shaped tubes at the base of each panel, and is distributed by means of an air-box provided with numerous holes and extending the whole width of the panel

* Messrs. Richardson & Cruddas, Byculla Ironworks, Bombay. They have increased the price to Rs. 590 since this article was written.

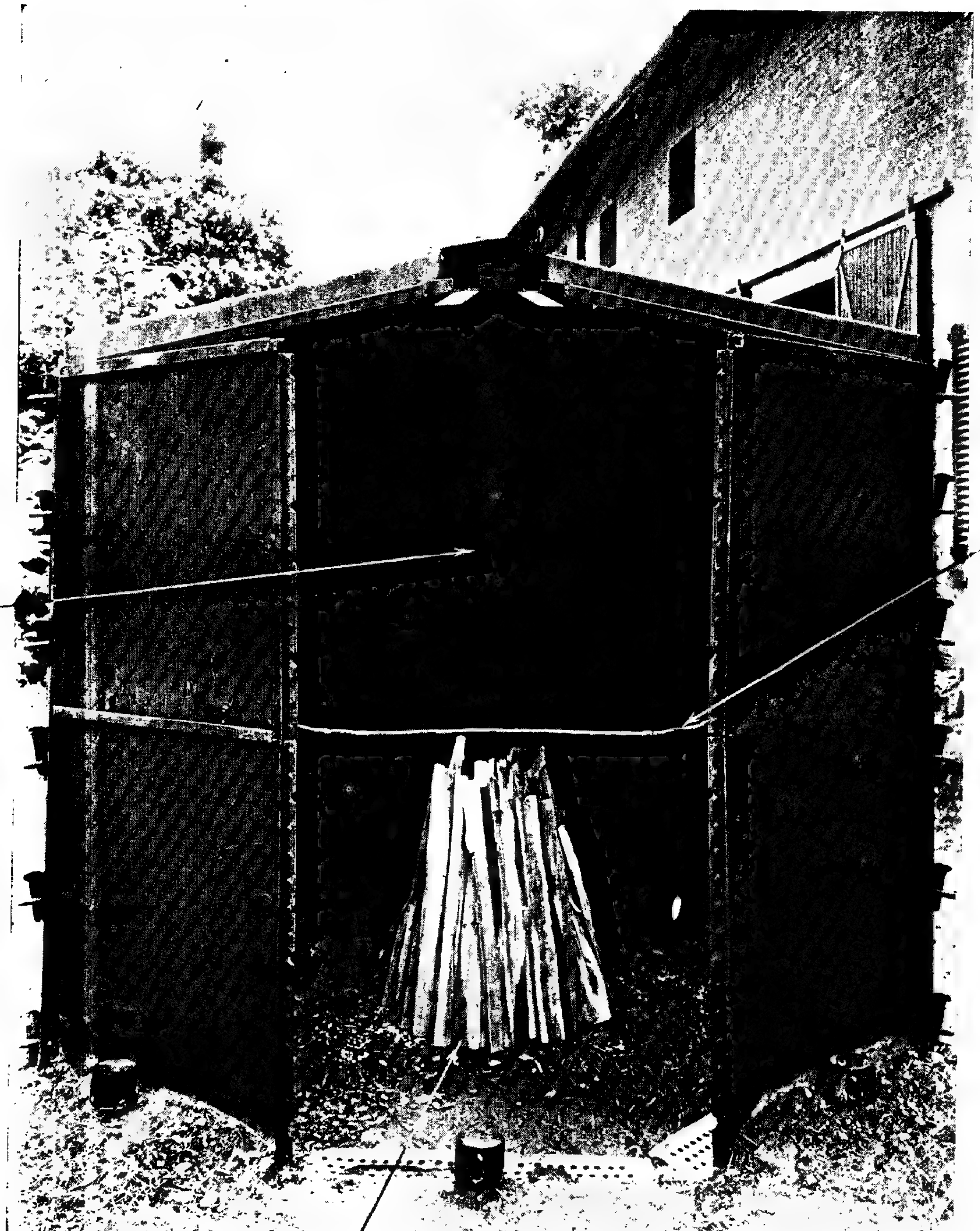
at the bottom of the inner side. The smoke from the kiln escapes through special outlets provided in each roof section. The air-inlets as well as the smoke outlets are adjustable, and can be opened or shut to any degree to obtain the desired results.

The Working of the Kiln.

The site on which it is desired to erect the kiln is cleared of weeds and levelled. The component parts of the kiln are then assembled with the conception of the roof sections, and the upper half of one of the side panels. The firing chimney is then placed in position. This chimney is a funnel-shaped tube of thin metal about 4 feet long. It reaches from the top collar to within about 18 inches from the ground at the centre of the kiln. Some easily combustible materials like wood shavings, dry twigs, etc., are then placed just below it on the ground in the centre of the kiln. Round these a cone is built up of split pieces of firewood of small size in order to facilitate later the rapid spread of the fire from the centre outwards. Fuel billets, preferably cut into 3 feet lengths are then stacked vertically round the centre chimney, with their thin ends downwards. The billets should be stacked as close as possible and no big air spaces should be left between billets. When the kiln is about half full the top half of the panel through which loading has been going on is placed in position, and other layers of fuel billets are arranged horizontally from the top till the whole kiln is tightly packed with wood. The largest pieces should be placed in the second layer, and any big gaps between large billets should be filled with smaller pieces of wood.

When the kiln is full the roof sections are placed in position, and all joints are packed with dry sieved earth. When all is ready the kiln can be lighted. To do this a shovelful of burning embers is dropped down the firing chimney from the top. The firing chimney is then withdrawn, and the space above the burning embers is carefully packed with thin pieces of wood dropped in from the top. It is essential that all air-inlets at the bottom of the kiln should be almost closed when the kiln is ignited, otherwise, the easily combustible matter in the centre will burn away quickly without setting fire to the surrounding billets. When the charge has fairly caught fire, as denoted by a

F. R. I. PORTABLE CHARCOAL KILN.



heavy whitish acrid smoke issuing from the top of the kiln, the smoke-outlets in the roof sections are half closed, and the air-inlets at the base are half opened. The central hole in the roof through which the kiln was ignited is then completely closed with the cap. After this very little further attention is required beyond slight adjustments to the air-inlets and smoke-outlets.

The best charcoal is obtained when the kiln burns evenly and slowly. One side of the charge should not be allowed to burn faster than the other. Should one side of the kiln get too hot, the air-inlets on that side should be partially or completely closed to retard the charring of the charge on that side.

The length of time taken for complete carbonisation depends upon the moisture content of the wood, the species used and the weather conditions. Green billets require a much longer burning period than partially or fully dried wood. The period of burning is also much influenced by the kind of wood which is being carbonised, hard dense woods generally requiring more time than soft woods. A heavy shower of rain while burning is going on, considerably cools the kiln and slows down burning but otherwise has very little effect. During a long course of trials the minimum time registered for complete carbonisation was 36 hours, and the maximum 97 hours.

While carbonization is proceeding, the condition of the wood inside the kiln can be judged by the colour of the smoke issuing from the vent holes in the roof sections. Clouds of heavy whitish acrid smoke indicate that the carbonisation process is in full swing. Gradually, the volume of the smoke becomes less and less, and the colour also changes to pale blue. The emission of a small quantity of pale blue smoke indicates that the charge is completely carbonised. When this stage is reached, all inlets and outlets must be completely closed and sealed with dry earth and the operation is complete. The kiln is then allowed to cool, and if all joints have been made perfectly air-tight, the cooling process will take about 12 hours.

When the kiln has cooled completely, one roof section and the corresponding side panels below it are removed. The charcoal will then be seen at the bottom of the kiln and can be shovelled out. If

the kiln has been made perfectly air-tight before cooling, no live charcoal should be present, when the kiln is opened. But, if the joints are leaky, some burning embers may be found. These should be removed at once and covered with earth until the fire is extinguished.

From the above brief description of the burning of the kiln, one very important fact becomes evident. This is that no water at all is used while burning charcoal in this type of kiln.

The average times required for the various stages of erection and burning are given below :—

	Hours.
Erection of the kiln	2
Loading of the kiln	3
Carbonisation	54
Cooling	12
Unloading of the kiln	$1\frac{1}{2}$
Number of coolies employed	3

It should be noted that three men can easily look after a battery of six kilns if everything is carefully planned beforehand, that is to say, if fuel is ready to hand, and firing materials, sieved earth and other necessary materials are also ready to be used as and when required.

Summary.

The advantages of the "Frikiln," are as follows :—

(1) It is readily portable by cooly, cart or animal transport.
(2) It can be used in hilly or level country.
(3) It requires no water.
(4) It can be used in all weathers and at all times of the year.
(5) There is no danger from fire.
(6) The outturn and quality of the charcoal produced are superior to those produced by the ordinary "country" methods of charcoal burning.
(7) The erection of the kiln is simple and can be carried out by ordinary coolies with very little instruction.
(8) The burning of the kiln is practically automatic.

The disadvantages are :—

(1) The rather high initial cost.
(2) The limited size of the material that can be carbonised. Billets of more than about 3 feet length and 15 inches diameter are not completely carbonised in portable kilns.

Specifications of the " Frikilns."

	Name of component parts.		No. required.	Wt. of. each. lbs.	Total weight. lbs.
1.	Side panels (top)	..	8	56	448
2.	Side panels (bottom)	..	8	58	464
3.	Screens ..	..	8	42	336
4	Roof section ..	..	8	62	496
5.	Channel iron ..	..	8	31	248
6.	Backing plate ..	..	8	12·5	100
7.	Air admission appratus :—				
	(*i*) Outer portion	..	8	16	128
	(*ii*) Inner portion	..	8	12	96
8.	Central lid ..	..	1	8	8
9.	Bolts and wedges (total)	..	..	..	50
10.	Roof support rafter	..	8	19	152
11.	Collar ..	..	1	37	37
	Total weight of the kiln			..	2,563

Average weight of wood carbonised in one run	.. 6,183 lbs.	The moisture content of the wood was found to vary between 43% and 86%.
Average volume of wood carbonised in one run	.. 225 c.ft.	Stacked.
Average outturn of charcoal	.. 977 lbs.	(oven-dry).
Height of the kiln	.. 7′ 6″.	
Diameter of the kiln	.. 7′ 6″.	

Blue prints of the scale drawings of the kiln can be obtained on application from the Forest Economist, New Forest, Dehra Dun, at a cost of Rs. 5 per set.

RESULTS OF TRIALS WITH THE F. R. I. CHARCOAL KILN.

No. of run	Locality.	Material carbonised.	Wt. of wood in lbs.	Wt. of charcoal in lbs.	Outturn %	Remarks.
1	2	3	4	5	6	7
1	Phandowala (Dehra Dun Division)	Sal ..	3,425	970	28·3	
2	,, ..	,, ..	4,000	986	24·7	
3	,, ..	,, ..	3,332	1,217	36·5	
4	,, ..	,, ..	3,622	1,348	37·2	
5	,, ..	,, ..	3,863	1,175	30·4	Burning took 97 hours on account of heavy rain during the run.
6	,, ..	,, ..	3,739	1,043	27·9	
7	,, ..	,, ..	3,766	1,043	27·7	
8	,, ..	,, ..	2,915	920	31·6	
9	,, ..	,, ..	3,490	1,006	28·8	
10	,, ..	,, ..	3,459	1,293	37·4	
11	,, ..	,, ..	3,288	1,059	32·2	
12	,, ..	,, ..	2,772	1,091	39·4	
13	Forest Research Institute grounds.	Mixed species. (Mango, toon, sissoo, *Ficus* and other hard woods.)	3,889	902	23·2	Bad mixture of woods. Some of the miscellaneous species burnt to ashes without producing any charcoal.
14	,, ..	,, ..	3,681	668	18·1	Ditto.
15	,, ..	,, ..	3,501	968	27·6	Ditto.
16	,, ..	,, ..	3,489	852	24·4	Ditto.
17	,, ..	,, ..	3,606	922	25·6	Ditto.
18	,, ..	,, ..	3,695	912	24·7	Ditto.
19	,, ..	,, ..	3,982	894	22·5	Ditto.
20	,, ..	,, ..	4,277	966	22·6	Ditto.
21	,, ..	,, ..	3,724	980	26·3	Ditto.
22	,, ..	,, ..	3,550	924	26·0	Ditto.

RESULTS OF TRIALS WITH THE F. R. I. CHARCOAL KILN—*concld.*

No. of run.	Locality.	Material carbonised.	Wt. of wood in lbs.	Wt. of charcoal in lbs.	Outturn %	Remarks.
1	2	3	4	5	6	7
23	Forest Research Institute grounds.	Mixed species (Mango, toon, sissoo, *Ficus* and other hard woods).	4,370	988	22·6	Bad mixture of woods. Some of the miscellaneous species burnt to ashes without producing any charcoal.
24	,, ..	,, ..	3,522	954	27·1	Ditto.
25	,, ..	,, ..	3,910	928	23·7	Ditto.
26	,, ..	,, ..	3,743	818	21·9	Ditto.
27	,, ..	,, ..	4,373	728	16·6	Heavy rain with hailstorm and strong wind. Airvents all found choked up with leaves and water.
28	,, ..	,, ..	3,709	590	15·9	Bad mixture of wood.
29	,, ..	,, ..	4,005	972	24·3	Ditto.
30	,, ..	,, ..	4,281	960	22·4	Ditto.
31	,, ..	,, ..	4,099	1,036	25·3	Ditto.
32	,, ..	,, ..	4,282	1,034	24·1	Ditto.
33	,, ..	,, ..	4,555	1,096	24·0	Ditto.
34	,, ..	,, ..	4,589	1,020	22·2	Ditto.
35	,, ..	,, ..	4,551	940	20·7	Heavy rain. Air-inlets found clogged with tar.

The figures in columns 4, 5 and 6 have all been given on an oven-dry basis.

... have all been given on an oven-dry basis.

STUDIES IN THE CONTROL OF THE SPIKE DISEASE OF SANDAL.

PART I.

THE ROLE OF INFECTION CENTRE AND LANTANA IN THE SPREAD OF DISEASE.

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S. RANGASWAMI (RESEARCH RANGER, NORTH SALEM, MADRAS).

The spike disease of sandal must be familiar to most readers of the *Indian Forester.* It would suffice, therefore, to merely point

out that a spiked sandal has not so far been known to recover. From the date of manifestation of symptoms a diseased tree dies in under three years. Another important feature of spike is that it induces sterility in the affected parts, though in the earlier stages, the apparently healthy portions produce an abnormal quantity of flowers. With the advance of the disease, however, the fruits formed from such flowers do not mature and consequently lose their germinative power.

The infectious nature of the disease was first shown by Coleman*[2] through cleft-graft and subsequently confirmed by Sreenivasaya[4] through several other methods. The manner of spread of the disease in a locality is somewhat erratic. The infection may manifest itself all of a sudden in one branch of a healthy tree or in a number of branches. It has also been observed on plants of all sizes and ages. Systematic records are not available for all the sandal areas, but the map and Tables I and II illustrate the position regarding the general distribution of sandal and the spread of spike disease in one of the richest sandal areas of the Madras Presidency. Information is also available regarding the distribution of infection among the different sized trees from a few representative areas, and also regarding mortality in sandal due to natural causes and to spike.

TABLE I.

Spread of sandal spike in North Salem Division.

Condition of sandal.	Extent of spread in acres.			
	1867.	1913.	1917.	1932-33.
Healthy	8,540	No record	54,103	38,764
Spiked	None	30	15,219	54,799

It is evident from the above that the disease is making rapid progress in the above division.

In the following table data are presented to show the distribution of the disease in heavily infected areas.

* Numbers within brackets refer to literature cited at the end of the paper.

Map showing Sandal areas and Spike occurence in North Salem Division. (Septr. 1933)

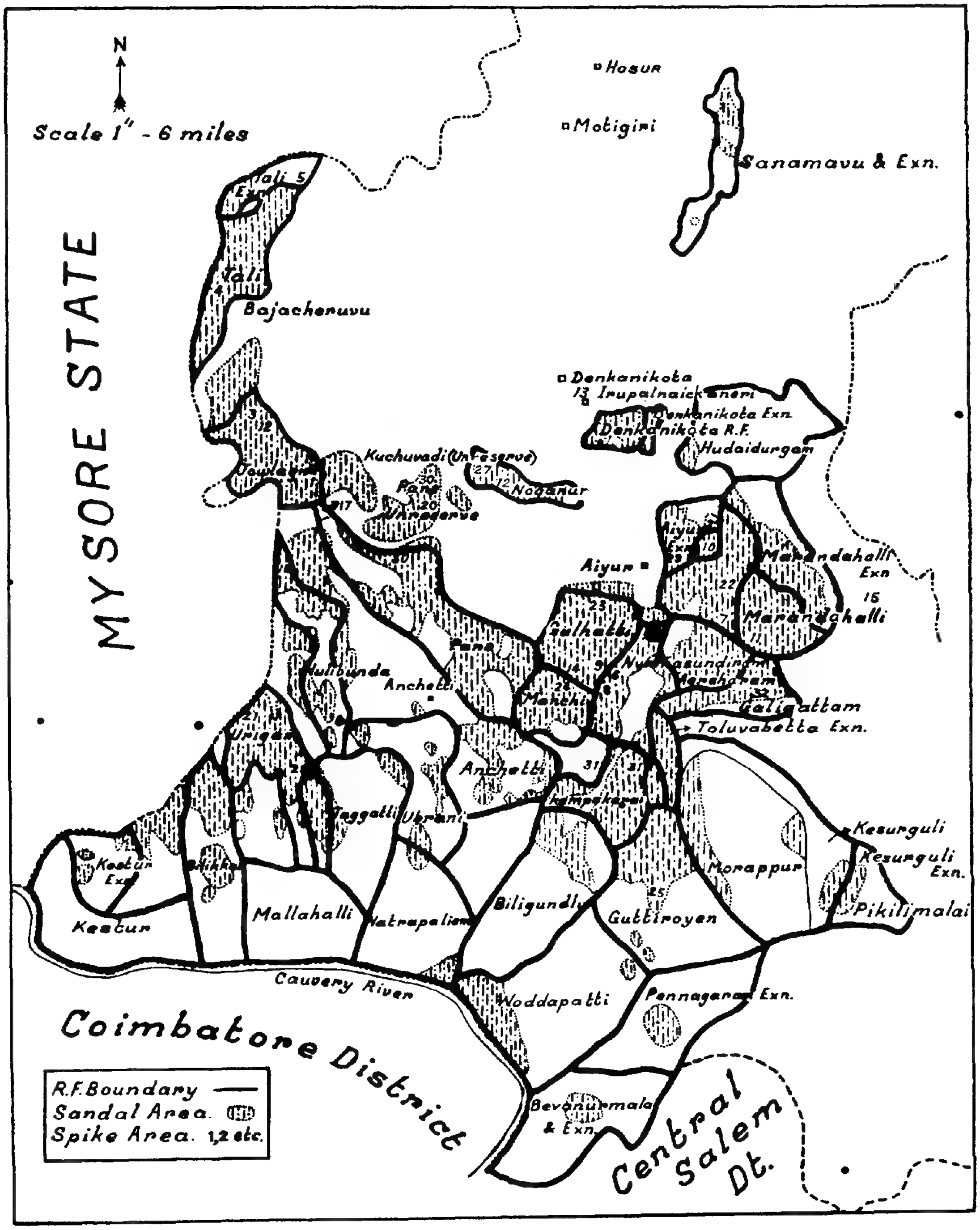


TABLE 2.

Percentage distribution of spike in some divisions of North Salem.

Girth class in inches.	Manchi Unreserve Part B—300 acres.			Galigattam area 300 acres.			Denkanikota area 200 acres.		
	Total No. of trees.	No. of trees spiked.	Per cent.	Total No. of trees.	No. of trees spiked.	Per cent.	Total No. of trees.	No. of trees spiked.	Per cent.
0—6 ..	3,813	142	3·7	3,649	151	4·1	5,065	236	0·50
6—9 ..	1,459	351	24·1	2,400	168	7·0	3,188	552	17·3
9—12 ..	1,120	423	37·8	1,416	209	14·7	1,657	351	20·6
12—15 ..	797	342	20·1	648	163	25·2	648	236	36·4
15—18 ..	613	273	44·5	435	117	26·9	239	76	31·8
18—21 ..	489	214	43·7	296	86	29·1	106	34	32·1
21—24 ..	359	167	46·5	187	62	33·2	22	14	63·6
24 - 27 ..	179	90	50·3	91	33	36·3	20	8	40·0
27—30 ..	129	41	31·8	62	14	22·6	7	4	57·0
30—33 ..	117	40	34·2	39	13	33·3	10	6	60·0
33—36 ..	54	32	59·3	33	13	39·4	3	1	33·3
36—39 ..	26	10	38·5	11	5	45·5	..	..	..
39—42 ..	40	12	30·0	15	6	40·0	..	..	..
42—45 ..	14	2	14·3	3	1	33·3	..	..	..
45—48 ..	3	1	33·3	5	2	40·0	..	..	..

[The above figures were collected during May 1934.]

It is clear from the above that the percentage of incidence of spike in the different girth classes in an infected locality is a varying figure and does not bear any direct proportion to the stock present therein.

It may be contended that mortality due to spike and natural causes may be more or less the same and hence any attempt to eradicate it will at best be only a palliative. The data presented in Table 3 will throw some light on this aspect of the problem.

TABLE 3.

Table showing the number of sandal plants dead in the forests of North Salem Division.

Girth classes in inches.	AIYUR COUPES III TO VI (6,832 ACRES).		THOLUWABETTA, COUPES IV TO V (2,855 ACRES).		GULHATTI EAST, COUPES II TO VI (3,001 ACRES).		GULHATTI WEST, COUPE VI (1,145 ACRES).	
	Dead naturally.	Spiked.	Dead naturally.	Spiked.	Dead naturally.	Spiked.	Dead naturally.	Spiked.
0—3 ..	451	1,120	72	636	106	901	..	23
3—6 ..	1,139	2,251	529	2,506	1,024	2,054	29	476
6—9 ..	897	2,265	894	2,496	1,141	2,972	225	522
9—12 ..	468	1,918	1,269	2,700	892	1,901	431	600
12—15 ..	187	1,683	768	1,846	560	1,717	337	302
15—18 ..	100	1,148	680	1,744	416	1,205	253	243
18—21 ..	53	823	289	1,178	241	961	157	93
21—24 ..	24	520	146	711	132	571	87	35
24—27 ..	16	360	84	404	38	232	47	39
27—30 ..	5	259	42	363	44	134	13	37
30—33 ..	6	136	23	193	14	64	8	8
33—36 ..	2	102	19	103	7	31	4	12
36—39 ..	..	45	9	26	2	9	2	2
39—42 ..	3	20	5	18	4	12	..	3
42—45 ..	..	12	1	15	..	5	..	..
45—48 ..	1	16	1	6	..	6	..	..
48—51 ..	..	3	..	4	..	3	..	..

It is regretted that the enumeration of the entire sandal stock though valuable would be impossible in view of the large areas involved.

It is evident from the above that there is no apparent correlation between the two figures. Death-rate due to spike is even more than 10 times that due to natural causes.

Control measures.—It is well recognised that plant diseases spread in nature through a variety of agencies such as wind, insects and birds. In the case of diseases caused by parasites the important factors that contribute to such spread are generally three-fold—(*a*) the existence of susceptible varieties, (*b*) the presence of the infection centres or foci—generally the diseased plant, and (*c*) the prevalence of the carrier of infection. Hence in the control of these diseases, it is common to remove the infective material by killing and burning the diseased plants or plant parts to treating the unaffected ones in the area suitably to minimise the harmful effect of the carriers, introducing comparatively resistant varieties and, if possible, destroying the carriers themselves. All the above-mentioned methods are generally adopted in the control of bacterial and fungus diseases of plants.

In the case of the pine diseases, particularly the Western Yellow Pine, eradication is a difficult problem. In the marking of trees to be felled, trees showing heavy infection are specially picked out. In this manner most of the affected individuals, which would otherwise act as sources of infection to subsequent regeneration are eliminated. But a complete eradication has been found impossible in this case. In the Chestnut Bark disease, a systematic eradication and destruction of all the infected trees has effectively checked the progress of the disease. In the European Larch Canker, which is a disease affecting forest trees, systematic eradication of the infected trees is the only solution so far known to control it. In all these instances the removal and destruction of the affected specimens is most efficacious when it is thorough. In the case of cultivated crops, this process is easier to adopt.

In the case of virus diseases of plants, a similar procedure has been highly useful. In Peach Yellows, prompt and thorough removal followed by the burning of the yellowed plants has resulted in checking the progress of the disease in the orchards. State Horticultural Laws and legislative enactments are in force for the compulsory destruction and effective eradication. In Little Peach, another disease of peach, the same method has worked very effectively. In the Leaf Roll

disease of Potato, the plots where the tuber is grown are carefully "rouged" and the plants sprayed for controlling the aphids that convey the several diseases while feeding. The crop is harvested early to avoid infection. Localities where the disease is prevalent are rejected for growing potato and seeds from disease-free areas are obtained. In the case of Potato Mosaic, the control of infection is almost similar, though somewhat difficult in view of the easy transmission of this disease by insects and also on account of the masking of disease symptoms by apparently healthy plants.

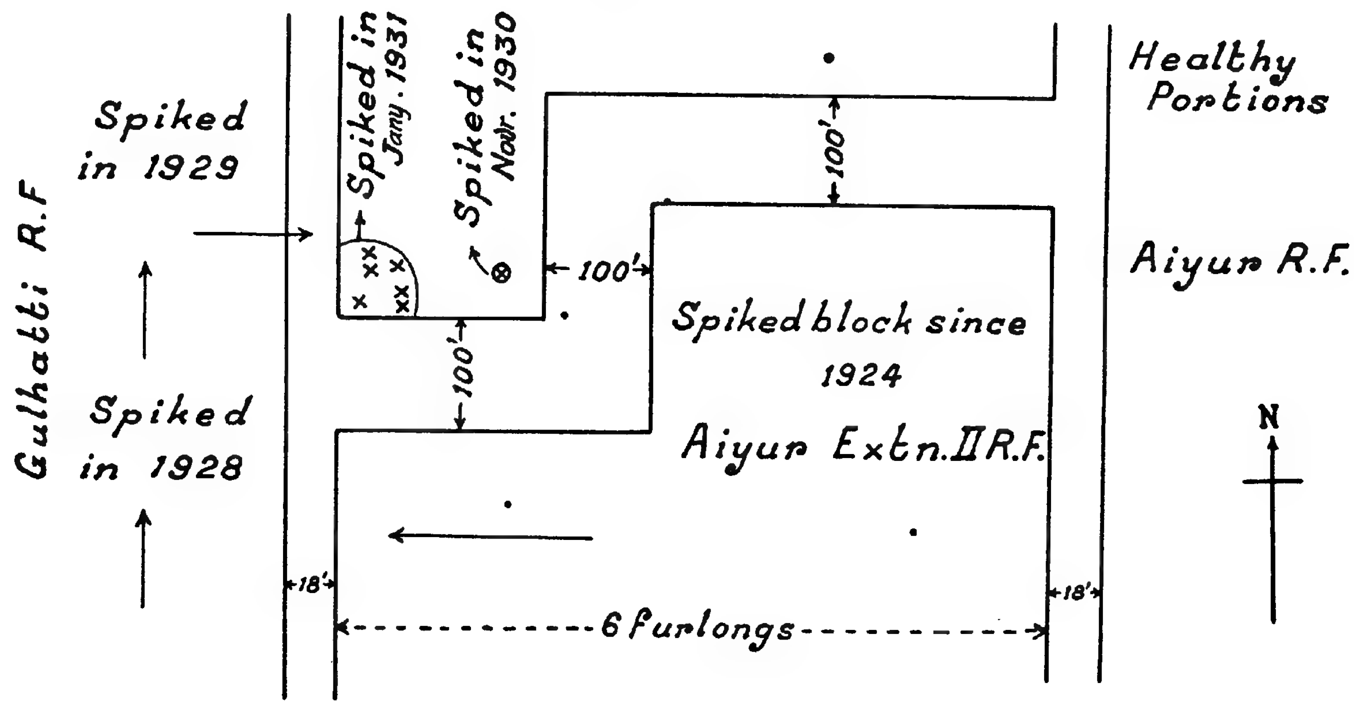
In the case of spike disease of Sandal, the causative agent of which has not so far been determined, the control measures have been varied. Butler[1] considered spike as being due to a virus circulating in the sap. Based on the occurrence of isolated healthy trees in a large patch of the infected ones, he suggested that a belt of country cleared entirely of sandal trees around the diseased districts would confine the disease to the affected area. He limited the width of the belt to 100 yards. Tireman in Coorg subsequently opened a belt two furlongs wide and two miles long, near Kargode, to prevent the disease from spreading northwards. The entire vegetation within the belt, including sandal, was uprooted between 1914-16. Unfortunately, the disease then began appearing even on the northern side of the belt, two trees getting spiked as early as 1916. Further observations are not available.

A further experiment was started in North Salem Division in 1928 and a line 100 feet wide was opened on one side of a spike area to prevent the spread of infection, all growth in the belt being completely cleared. The belt (*vide* Fig. I) was also ploughed up frequently to uproot all sundry vegetation.

The area north of the line continued healthy for a period of 6 years. In the meanwhile the disease spread westwards across a narrow line 18 feet wide into the Gulhatti R. F. and then spread northwards. In November 1930, two trees got spiked in the area north of the line (marked in Fig. I).

It would be seen from the above that the disease crossed the line again and then spread into the other side so that the 100 feet belt

Fig.I.



The arrow indicates the probable direction of spread.

would appear to have effectively kept out the disease for some length of time. Even though spike is known to skip over long distances, the secondary spread around the centre of infection appears to have been controlled by the cleared belt for a time.

It is interesting to find that this practice is adopted in the control of Peach Yellows, wherein a belt of 300 yards from the nearest diseased plant protects the healthy patches for considerable lengths of time.

The general method in the control of spike has thus been to remove the affected trees including the roots, collect them together and burn them after rough-cleaning for the valued scented wood. The adoption of the above procedure, though very costly, has still effectively checked the progress of the disease in some areas where the initial attack was promptly discovered. At Nellivasal on the Javadis in West Vellore Division, where the disease was first noticed in June 1917 over an area of 30 acres, Lushington had all the sandal, *Zizyphus oenoplia*, *Dodonea viscosa*, *Cipadessa fruitcosa* and *Arygyriea cuneata* in the area removed. By thus removing all possible sources of spike from the Reserve forests and other Government lands the area has been freed from spike since 1932.

Isolated attacks of three small trees in the Noganur R. F. in September 1921, of 10 trees at Irupalnayakaneri near Denkanikota in November 1921, and of 70 trees at Pullahalli in 1922 were noticed and prompt and complete eradication was carried out. No recrudescence has so far been noticed in these areas. In one of these (Noganur R. F.) quite a different part of the reserve was found diseased in 1929 but the original patch is still healthy. Similarly in Ganjam District, at Chatrapur, Cox destroyed two small trees attacked in January 1922 and no further outbreak has occurred since that date.

The experience gained from the above has clearly established the efficacy of removing diseased trees in checking the progress of the disease in localities where spike has freshly broken out. But the method of uprootal by mechanical means and burning the same does not conduce to cheapness. The cost of the operations is considerable and the work necessarily slow unless implemented by concentrated

labour which makes the cost prohibitive. Largely owing to the above, several big sandal areas in which spike had already established itself have now gone out of control.

In these large areas another practice was adopted by rewarding men at the rate of one anna for every diseased sapling that was pulled out. This was also found impracticable as it resulted not only in hasty, partial uprootal of spiked plants but also, for obvious reasons, in the vigorous destruction of healthy saplings as well !

As a result of the unchecked depredations of the disease, we now find that in Jawalgiri R. F., which contained trees of all girth classes up to 54 inches even as late as 1925, it is now hardly possible to obtain even a single tree of 15 inches girth and above. In Aiyur R. F., instead of 45 trees which on an average yielded 1 ton of heartwood in 1922-23, 332 trees had to be uprooted in 1929-30 to make up a ton, thus establishing the destructive effect of spike.

Lantana in relation to spike.—It is an established fact that spike is most virulent in areas where lantana is the predominant form of vegetation. This was recognised as early as 1917 by Tireman and experiments were carried out by him in Chinnanahalli area in Coorg to see if spike can be minimised by complete eradication of lantana.[6] He opened four plots of which two were kept as controls and two cleared of lantana. The results obtained by him show that the incidence of spike in an area is considerably influenced by the presence of lantana. He recorded that in a plot of 17 acres, the continued removal of this species was responsible for the diminution in the percentage of attack. Thus the number of sandal trees which got spiked during six years was only 200 out of a total of 972 in the above plot, while it was as high as 600 out of a total of 721 in a similar plot, from which lantana had not been eliminated. It must be pointed out here that the diseased plants were removed once a year from these plots. A view has long been prevalent that the disease started soon after the introduction of lantana, though there is no foundation for this.

The rôle of lantana in predisposing sandal to disease has been emphasized by Rangaswami and Sreenivasaya[5] who showed that

the aggressive invasion of lantana has almost always preceded the incidence of spike disease in any particular area, the abundance of lantana in a spiked area being 15 times as much as what is normally found in a corresponding healthy area. Exceptions of this view are, however, not wanting.

Systematic records are not available for the spread of lantana in different sandal areas, but the following figures (Table 4) which relate to North Salem will serve to illustrate the position.

TABLE 4.

Table showing the distribution of Lantana in the North Salem Division.

Range.	Area under lantana in acres.	
	1917.	1931.
Dharmapuri ..	Nil	20,844
Anchetti ..	45	37,524
Denkanikota West ..	1,472	45,806
Denkanikota East ..	2,005	35,090

It is, therefore, apparent from the above that the problem of spike control is intimately connected with the control of lantana in infected sandal areas. The importance of this subject has already been stressed by A. V. V.[7] in an earlier publication. The results so far obtained indicate the possibility of employing chemicals in destroying that weed. Further work on this aspect of the problem is in progress and will form the subject of a later communication.

Summary.

(1) The rate of spread of spike disease in any locality is independent of the size and age of the sandal plant.

(2) The presence of lantana has been found to increase the incidence of spike.

(3) It has been possible to control the spread of the disease through effective and thorough removal of diseased plants and burning them.

In conclusion, our thanks are due to Prof. V. Subrahmanyan, D.SC., F.I.C., for kind suggestions and criticism and to Mr. A. M. C. Littlewood for his keen interest in the problem.

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THE USE OF PAPER TUBES IN PLANTING WORK

By Bachaspati Nautiyal, Forest Ranger, F. R. I.,
Dehra Dun.

There are several tree species, the seedlings of which cannot easily be planted out from the nursery unless a ball of earth is kept round the roots. The value of a cheap sufficiently rigid but ultimately perishable container to minimise disturbance to the root and to facilitate and cheapen handling is obvious, and many varieties have been tried in India and abroad, the best known being the split bamboo tub . It was thought advisable to try out treated paper containers at the Research Institute in view of the special facilities available, and *Pinus longifolia* was selected as the transplant since there happened to be some infilling required in our plantations.

Under damp conditions during the rains at Dehra Dun, the *chir* seedlings have a tendency to damp off when in the cotyledonary stage, and moreover, direct sowings can only be commenced at the break of the rains when about half the potential growing season for *chir* is over. Plants raised in tubes at the beginning of summer and planted *in situ* at the break of the rains have thus the further advantage over direct sowings that the growing period is increased by about 3 months.

The tube planting was tried in 1933 to fill up minor failed blanks in the 100 acres of *chir* plantation at New Forest.

Unbleached paper roughly of the thickness and texture of ordinary botanical drying paper was obtained from the Paper Pulp Section, cut in pieces 11" long and 8" wide. Two cuts 3" deep were made in from the sides of the paper 2" from one end. The paper was then rolled round a length of bamboo of about 2" diameter. The 2" bottom strip of the paper was bent up as to form the bottom of the tube and the flaps bent up along the cylinder and then tied with twine. The upper part of the tube was similarly tied near the top and also at the middle. The tube was then slipped off the bamboo. The size of the tubes was then 9" long and 2" in diameter with about 1" overlap along the side (See Fig. 1 Plate 7).

About 500 tubes were then subjected to each of the following antiseptic and waterproofing treatments :—

1. Dipped in molten paraffin wax at a temperature of about 90° C.

2. Dipped in molten paraffin wax at a temperature of about 90° C mixed with Paris green (1 oz. of Paris green to 20 lbs. of wax).

3. Dipped in molten paraffin wax at a temperature of about 90° C mixed with naphthalene powder (1 oz. of naphthalene to 5 lbs. of wax).

4. First dipped in cold 5% copper sulphate solution in water then left over night for drying; on the following morning dipped in hot waterproofing composition containing 50% petroleum asphalt and 50% earth oil.

5. The same antiseptic and waterproofing treatment was given as to those of lot No. 4 but 20% rosin was added to the waterproofing composition.

6. These were dipped only in a waterproofing composition of the kind used for treating lot No. 4.

After treatment the tubes were allowed to dry in the shade, requiring 2 weeks for the asphalt lots, and then they were filled with soil consisting of 1/3 sand, 1/3 rich humus soil and 1/3 ordinary loam. They were then put out in the open each lot in a compact block the

tubes all touching, and sown with pregerminated seed—one seed per tube. The seedlings at the end of July were about 3″ to 4″ high and were planted out with the tubes intact, after tearing off the paper at bottom.

Of all the treatments applied 1, 2, 3, and 6 were found equally satisfactory while many of the tubes treated under 4 and 5 collapsed before planting. In no case were the tubes found to be attacked by white ants.

Light wooden trays 18″ square with a capacity of 100 tubes each were used for carrying tubes to the planting site.

The following are figures for cost per acre of preparation and planting of paper tubes :—

(*a*) One man can prepare 125 tubes in a day; cost per acre at 6′ × 6′, labour -/6/- per diem, Rs. 3/10/-.

(*b*) $1\frac{1}{2}$ lbs. of wax can treat 125 tubes; cost per acre @ -/8/- per lb.=Rs. 7/4/-.

(*c*) 1lb. of Petroleum asphalt or spramax mixed with $\frac{1}{2}$lb. of earth or crude oil can treat 250 tubes; cost per acre, @ -/5/- per lb. = Rs. 1/8/-.

(*d*) One man can fill with soil and sow with pregerminated seed 750 tubes in a day; cost per acre, labour at -/6/- per diem = Rs. -/10/-.

(*e*) One man can prepare the pits and plant 100 tubes in a day; cost per acre (1,210 plants) = Rs. 4/8/-.

The total cost per acre, using tubes waxed only is thus Rs. 16/- with 6′ × 6′ spacing. This does not include the cost of paper. On inspection in October 1933 about 95% were observed as alive. In April 1934, 60% were observed alive, the rest were mostly bitten off by hares or killed by rats.

At the end of hot weather 1934 it was observed that further casualties had occurred but they were again more due to hare damage than to drought, the single isolated seedlings being conspicuous and easily detected by hares.

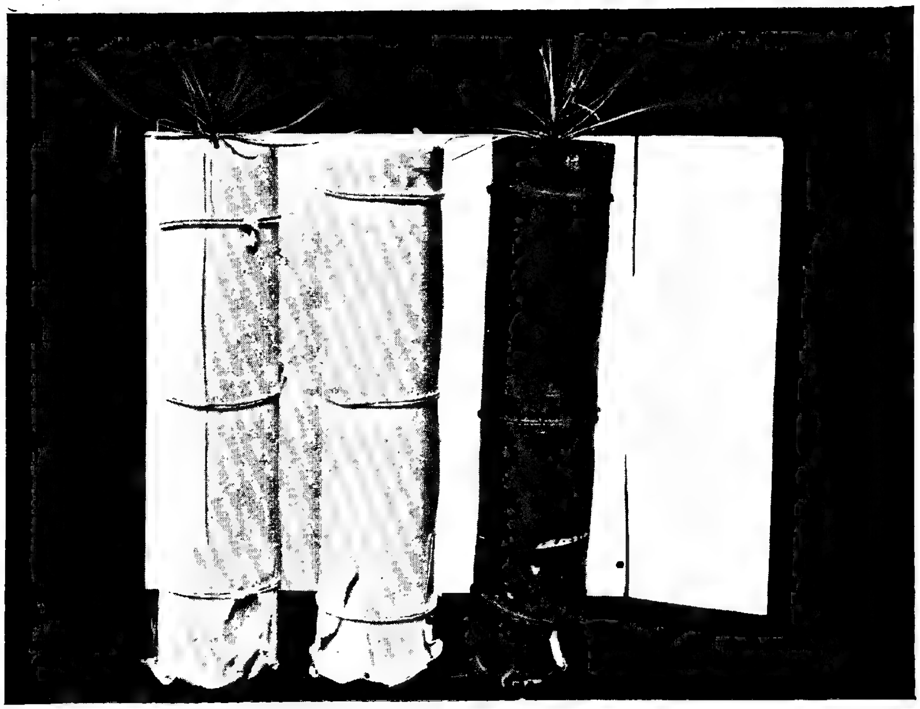

Fig. 1.

Use of paper tubes in planting work. *Behind,* a sheet cut ready for folding; *right,* tube waterproofed with petroleum, asphalt and earth oil; *left,* tubes waterproofed with paraffin wax.

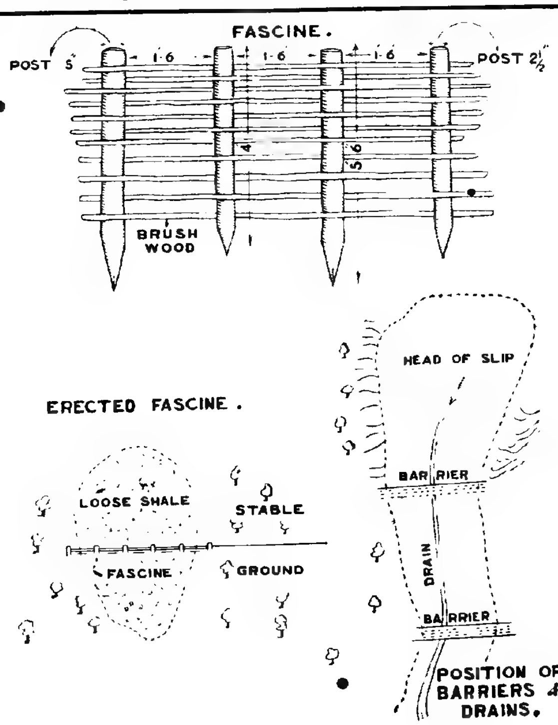

Fig. 2.

The growing season having been an exceptionally bad one especially for seedling *chir*, the necessary controls were not available to compare the year's growth with direct sowing. This experiment, therefore, can only serve to show that the method is a perfectly practicable one, at a quite reasonable cost which should be justifiable in many localities where direct sowings or naked root transplanting is unsuccessful and balled transplants difficult to apply.

PROTECTING NAINI TAL FROM LANDSLIPS BY RECLAMATION OF DENUDED HILL SLOPES.

By M. A. Kakazai, Silvicultural Branch, F. R. I.

It had been noticed that detached rocks occasionally rolled down from the slips on South China slopes and damaged houses from Oakover to Wood-stock. In 1905 such rocks damaged out-houses in the compounds of Col. Clarke and Major Nories. It was, therefore, moved by the United Provinces Government that some shrubs etc., be grown on the moving shale and the Forest Department was required to make out a scheme. The following notes summarize the recommendations of Mr. Lovegrove, who was then in charge of Naini Tal Forest Division, together with improvements based on experience gained during work.

The slopes between the main ridge and Upper China Mall consist of an upper zone of precipitous cliffs with a lower zone of steep scree slopes. In the former nothing can be done except the removal from time to time of dangerous overhanging rocks. In the latter much can be done to lessen the present risk from avalanches and the following notes would apply to them. The slopes are at nearly all angles and are partly covered with tree growth intermixed with narrow and wide vertical bands of scrub, grass and loose moving shale on which no growth exists. The forest clad areas need not be touched, but all the rest should be treated in the manner suggested below :—

(*a*) The whole area should be protected from grazing and cutting of grass and brushwood and should be wire fenced.

(*b*) The further treatment should depend on the condition of the area.

(i) Scrub covered area.

Sowing and planting of *Populus ciliata*, *Quercus dilatata* and *Q. incana*, *Cupressus torulosa*, and *Betula alnoides*, whose longer roots will help to increase the stability of the soil, should be done. Poplar being quickest growing should be largely used and propagated from cuttings.

(ii) Grass covered areas.

Sowing of local shrubs followed by planting of deeper rooted trees when these are established. The shrubs should be sown as much under cover as possible.

(iii) Loose moving shale.

Every heavy fall of rain causes the shaly pieces to shift one over the other downhill. It is therefore necessary first to erect drains, barriers, and fascines to fix this moving material.

(a) *Drains* similar to those put on this slope should be erected on the landslips started this year.

These drains take off the surface water passing over the landslip basin as quickly and quietly as possible and thus reduce slips.

(b) *Barriers* or firm masonry walls built across the area under treatment act as a foot to what is above. Barriers should be made in the two narrow bends in the new slip. They should have a stepped slope on the lower side and must be firmly tied to the side banks.

An ordinary barrier of earth may be erected above the Mall to stop the boulders that might pass down the works.

(c) *Fascines.*

These are wooden structures consisting of posts interlaced with brushwood as shown in the sketch. The posts should be used with bark on, and the right way up, as some of them may strike and form useful live supports. They should be sunk into the *bajri* leaving only 1′ to 2′ above the ordinary surface. In the centre of the fascine or where the loose stones are most likely to find passage, leave a hole (4′ × width of fascine above the surface) in order to allow surplus earth and stones to pass through. This would prevent accumulation of material at an impossible angle of repose.

Several fascines (2, 3, or 4) depending on the length should be put across each band of loose shale. These help in the fixing and consolidation of the screes and make them fit for introduction of plants and trees. Along main lines such as the centre of the new slip no fascines should be put up, the work being arranged so as to converge gradually from the sides. If any holding up is wanted on the main line, a barrier in the absence of drains should be prescribed. Fascines can be placed with advantage some few feet immediately below the foot of the steeper slopes and not near the tops. By this means ultimately a more general slope will be obtained in which the rubble is in a position of rest. (Sketch of fascine, barrier and drain are shown in Fig. 2, Plate 7.)

It is necessary to cover such places, when fixed, with small vegetative growth, *viz.*, shrubs and grasses, as quickly as possible, and for this purpose commonest plants growing on local exposed places should be selected. After these shrubs get established trees should be planted. The following shrubs and herbs were recommended for China slopes.

(*i*) *Shrubs.—Cotoneaster microphylla, Colquhounia coccinea, Coriaria nepalensis, Viburnum continifolium, Indigofera heterantha, Berberis aristata* and *Desmodium tiliaefolium.*

(*ii*) *Herbs.—Artemisia vulgaris,* and *Hedychium acuminatum.*

Sowing technique.—For sowing, 1 seer of seed should be well mixed with 1 maund of black soil and spread over the ground. The whole of the ground should receive a top dressing of soil. The earth should be taken from under the trees in the existing patches of growth, care being taken not to undermine material that may slip. The seed should be sown both above and below the fascines.

The local Government agreed to these proposals on 16th December 1905 and work was taken up in 1906.

In May 1906, the Municipal Board erected a wire fence on the lower side of the area (590′) at a cost of Rs. 1,031/- and the Public Works Department made masonry barriers in the same year in the new slip. They also partly constructed a dam above Oakover Lodge.

The drain up this new slip was abandoned, above barriers being erected in its stead. Nine fascines were erected in the year 1906-07 at a cost of Rs. 351/- and for these following material was required :—

Poles 20′ to 31′ long—140 number.
Brushwood .. 230 head loads.

Seeds of shrubs and herbs were sown above and below the fascines and handfuls of seed-earth mixture were scattered over soils of shifting character here and there. Seed of shrubs was sown in areas covered with grass. Self sown poplar seedlings from reserved forests and cuttings of the same were put out $1\frac{1}{2}'$ apart in lines in 3 rows on the lower sides of fascines. 400 head-loads of black soil were used for sowing seed.

In 1906-07, a portion of land adjoining the previous year's slip moved down and embedded a fascine. This fascine checked the speed of the rolling stone from the new slip with the result that the stones and earth settled down quietly behind the fascine which was completely buried.

It was found that protecting the young seedlings from sun on such heat-absorbing material as bare *bajri* is absolutely necessary and some form of shelter of available grass and brushwood from perfectly stable places was recommended.

In 1907-08, a few new bunds and one new fascine were constructed. Three maunds of seed of shrubs was sown and some grass rhizomes put out. Some seedlings of poplar, willow and oak were also planted.

A prolonged drought proved too much for many of the seedlings, but still the results were very encouraging.

In 1908-09, 218 seers of acorns and miscellaneous seeds were sown and 6,927 seedlings of oaks, poplar, and willow and 12,600 grass rhizomes planted. The results were in spite of drought very encouraging and 7,000 of the last year's plants were found living.

1909-10. Sowings and plantings were done as in the last year. Nothing has as yet succeeded on bare *bajri* although all kinds of seeds and shrubs have been tried.

1910-11. Twenty seers of seed of miscellaneous species was sown and 13,531 seedlings were planted.

1911-12. 2,800 cypress and oak plants, 3,550 grass and other plants, and 300 shrub and poplar cuttings were planted. Seeds of cypress and *chaulai* (*Wendlandia exserta*) were also sown. A small nursery was started in Almagadhera.

1912-13. 19½ seers of seed of various kinds was sown and 900 cuttings and 7,500 grass and other plants were put in. Previous year's poplar cuttings are doing well.

1913-14. 11 maunds of grass and other seeds were sown and 681 plants of different kinds and 1,448 cuttings of poplar were planted. In addition cypress seed was sown in 3,000 patches and some grass rhizomes planted. This work is nearing completion and a committee will shortly consider what more is required.

Mr. Smythies in his report dated 21st September 1912 summarised the work as follows :—

The work in the past 4 years or so has been done on the right lines and is for the most part distinctly successful, but 3 to 4 years' more work will be needed before the present necessary operations are completed.

The works remaining to be done are :—

(*i*) Three fascines in loose scree immediately to the east of the main drain and one fascine in the small scree to the east of the next large drain further east ; (*ii*) 5 acres of grass land to be sown up with seeds of shrubs and herbs ; (*iii*) 4¾ acres of fairly firm scree to be planted up with poplar and *gharri* slips and sown with cypress ; (*iv*) 3 acres of loose scree and banks of drains to be planted up with grass rhizomes.

Mr. Stevens in his note dated 24th July 1914 makes the following suggestions :—

(*i*) As sowing has not been successful in grass and scrub areas, nurseries may be started for raising plants to fill these up.

(*ii*) As the old fascines made by Mr. Lovegrove have disappeared and as they proved very useful, it is desirable to make some new fascines in suitable places.

(*iii*) Erection of *pucca* drains is of first importance. He, therefore, moved the Municipal Board to apply for a grant of Rs. 6,000/- spread over 10 years for these works from the Government.

Mr. Smythies referred to this point on 21st April 1915 again and said, " The question turns on the degree of safety required for these slopes. Past work has undoubtedly had beneficial effect and I believe that nowadays falling stones do not often reach the Upper China Mall, whereas 6 years ago stones and rocks used to descend occasionally to the bungalows below. On the other hand, perfect safety has not yet I think been obtained and to fix the bad shale slopes now remaining will undoubtedly be a slow and expensive process."

Thereafter he made a joint inspection of the really bad slip with the Secretary of the Municipal Board and the District Engineer, and the following conclusions were arrived at—" There has been no trouble from falling stones or *bajri* for the last 5 years and it appears that material improvement of these slopes since protection was started has made them fairly safe; the work of the Forest Department should be considered as completed." It was however emphasized that the area should be kept closed to grazing and grass-cutting.

The total expenditure on the work was roughly Rs. 6,800/- which was spent as follows :—

(1) Making of barriers and dams by Public Works Department	Rs. 3,200
(2) Erection of fencing by Municipal Board ..	Rs. 1,031
(3) Expenditure on making fascines and sowings and plantings through Forest Ranger, China Range	Rs. 2,569
Grand Total ..	Rs. 6,800

Mr. Mobbs, Provincial Silviculturist, Naini Tal, has kindly inspected this area with the original map in August 1934, and following summarises his note.

It is difficult now to distinguish the sowings and plantations from the natural regeneration that has followed the stabilisation of the soil and has been possible on account of continued protection, but taken

as a whole the original work can be considered as eminently successful.

The loose moving shale and grass and scrub covered areas are now mostly covered with fairly dense forest of miscellaneous shrubs and young cypress and *Quercus dilatata*, with a well established undergrowth of grasses and herbs. There are occasional old trees and quite a number of young cypress which are too old to have been planted in 1906—15 and were presumably on the *bajri* before the reclamation works began.

In the upper parts of the *bajri*—areas, patches are well covered with shrubs, young cypress and *Populus ciliata*, but other patches are more open due to the falling of rocks from precipices above, which it is impossible to prevent.

Of the trees put out cypress and *Quercus dilatata* seem to have been the most successful. *Populus ciliata* was apparently put out in the uppermost parts where it has grown quite well but has suffered considerably from falling rocks and new slips.

Of the shrubs *Coriaria nepalensis* has done well both in the lower as well as uppermost parts while *Viburnum cotinifolium* and *Desmodium tiliaefolium* and others have done fairly well in the middle and lower parts. *Cotoneaster microphylla* was apparently put on loose scree and in patches has developed well and covers and binds the soil well.

Both the herbs, *viz.*, *Artemisia* and *Hedychium*, have done fairly well. In many patches the grass is well established but elsewhere particularly to the east it is patchy, and in places is not sufficient to hold the loose surface scree.

The trouble of falling rocks chiefly to the west of the main drain on which side very little work was done originally, has increased in recent years, and in order to stop them embankments have been built above the Upper Mall. These land slips in addition to their being a source of great danger to the population below are doing much damage to the new forests which have come up as a result of protection. The mitigation of landslips can be effected by reclamation works only, and it is therefore suggested that such works as construction of drains and fascines and planting grasses, herbs and shrubs and trees may be taken in hand on the new scree areas.

THE INFLUENCE OF FORESTS IN THE ECONOMY OF MANKIND.

BY A CANDIDATE FOR RANGERSHIP.

[The following essay on "The Influence of Forests in the Economy of Mankind" by a candidate for the post of Ranger is reproduced for the edification of our readers—C. G. T.]

"Man thou art a wonderful animal. Thou can suck out good from the worse itself" says Thomas Carlyle in one of his beautiful essays adorning "the galaxy of literary stars." How in a fit of ecstacy yet rightly were these words pronounced. And Forests do offer a justification to them in more sense than one.

Vegetable kingdom was probably the first and foremost thing to occupy this universe. Though our knowledge about the origin of mankind is more an imaginary thing rather than real and substantial, yet, it is a matter of common sense, that the first problem, which must have met it, was the clearing of forests to make room for itself. But that was not all; and this was not the real object too. Mankind busied itself not in rendering a death-blow to this whole vegetable kingdom but arranging it in a way as to make the most of it. And surely this is due to this modification and rectification of forests that we see, to-day, the various advantages and manifold uses, which forests have been put to.

The uses of forests are so innumerable that they can be divided, broadly speaking, under three heads, according as they touch the material or economic, social, and also the physical aspects of human-life. But it can be said once for all that forests have effected the material aspect more than any other.

Apparently one would feel that forests have procured only fuel and timber for us. Nay, they have, thereby opened gates to so many industries and factories. But for them, it is without exaggeration a fact, this world would not have seen the Bobbin factory, ; the Katha factory, the Match factory, and many more, working on its bossom; and naturally all the industries consequential to them would have been the things of mere dream and imagination.

But since man has diverted his attention to the direction of forests, forests have become the places more suited to the lives of

human beings, rather than the savage beasts. Tens and thousands of men have now been employed in this—the Forest Department as it is named —and are blessing their stars; and yet another instalment of human race is ever ready and crazing for it.

Now the forests have been divided into several divisions and ranges. The work has been so regulated and modified that forests are no longer terrors to humanity. "Forest Life" is no more barbaric, reserved, and savage in its character as one might assume. It has certainly a social and cultured touch in more senses than one.

In Japan, as we know people make their houses of wood. And one can easily picture in his mind what should have been their fate had there been no forests and hence no wood. It is, indeed, so heart-rending and pitiable to anticipate such a hard luck. Japan, a place of volcanoes and earthquakes, should have kissed the ground and probably lost its existence without wood long ago.

These are the few more important uses which the forests have rendered and are ever rendering to mankind materially and economically.

Now coming to those which effects the physical aspect of our life, we find several forests being given rise to what prove "as natural-cures." For example, there are euclyptus forests, deodar forests, and so on, which make the climate best suited and most effective to a particular type of diseased men. We have one of the first kind, I mean euclyptus, at Lansdowne, where patients suffering from "T. B." are kept.

Again, wood being a very light thing it can easily float on the surface of water, and hence boating, which, besides being a pleasant hobby to young as well as old minds, offers a means of transportation also.

Thus, in a nutshell, forests have added much to the safety, comfort, and above all mitigated to a very great extent the problem of unemployment and economic depression, a burning question which, to-day, is confronting every country, and India, in particular. And "Forests" are certainly "For—Rest" as one would easily analyse in calmer moments from this particular point of view.

I.

Table showing the trade in Teak between each Province and Indian State and Chief Seaport (in cubic feet) during the month of September, 1933, *and in the* 6 *months,* 1*st April to* 30*th September,* 1933.

Articles and whence exported.	Assam.	Bengal.	Bihar and Orissa.	U. P.	Punjab.	Sind and British Baluchistan.	C. P. & Berar.	Bombay.	Madras.	Rajputana.
	IMPORTED INTO PROVINCES, EXCLUDING SEAPORT TOWNS, INTO STATES AND CHIEF SEAPORTS.									
TEAK—										
Assam	..	..	..	..	..	..	..	..	..	..
Bengal	67·64	..	605·20	7·12	..	..	..	..	..	2527·60
Bihar and Orissa	..	3·56	..	..	..	..	..	..	..	..
U. P.	..	..	3·56	..	3·56	..	..	..	..	..
Punjab	..	..	26·70	623	..	..	..	..	..	..
Sind and British Baluchistan ..	..	..	..	..	16·02	..	..	..	..	..
C. P. and Berar	..	..	..	..	..	..	..	..	..	..
Bombay	..	..	..	..	3·56	..	..	..	7041·68	1678·54
Madras	..	..	..	..	..	..	..	49·84	..	..
Rajputana	..	..	..	..	..	..	..	..	..	..
Central India	..	..	..	..	..	..	..	..	..	49·48
Nizam's Territory	..	..	..	..	..	..	..	1210·40	2228·56	..
Mysore	..	..	..	..	..	..	..	1·78	185·12	..
Calcutta	144·18	9143·86	6002·16	2016·74	10678·22	..	7·12	..	1·78	..
Bombay Port	..	..	..	1·78	12·46	..	103·24	36468·64	..	6516·58
Karachi	..	..	..	..	3978·30	3342·84	..	..	..	1194·38
Madras Ports	..	..	..	..	..	..	..	..	36726·74	..
Total for September ..	211·82	9147·42	6637·62	2648·64	14692·12	3342·84	110·36	37730·66	46183·88	11966·94
Total for 6 months, 1st April to 30th September 1933 ..	1032·40	75511·16	23471·08	40617·82	56602·22	17278·46	1087·58	251649·28	430137	66413·58

NOTE.—Maunds have been converted into cubic feet at the rate of 1 : 1·78 based on 1 ton=50 cubic feet.

I.

Table showing the trade in Teak between each Province and Indian State and Chief Seaport (in cubic feet) during the month of September, 1933, and in the 6 months, 1st April to 30th September, 1933.

Articles and whence exported.	Imported into Provinces, excluding Seaport Towns, into States and Chief Seaports.								
	Central India.	Nizam's Territory.	Mysore.	Kashmir.	Calcutta.	Bombay Port.	Madras Ports.	Total for September 1933.	Total for 6 months, 1st April to 30th September 1933.
TEAK—									
Assam	..	..	..	..	..	..	..	..	16801·42
Bengal	..	..	..	..	..	..	..	3207·56	50409·6
Bihar and Orissa	..	..	..	..	5·34	..	..	8·9	14964·46
U. P.	..	..	..	..	1·78	..	..	8·9	7406·58
Punjab	..	..	..	..	..	..	..	649·7	23891·16
Sind and British Baluchistan ..	..	..	..	..	..	..	..	16·02	28·48
C. P. and Berar	..	2228·56	..	..	..	968·32	..	3196·88	62572·34
Bombay	1949·1	133·5	1954·44	..	..	923·82	..	13684·64	72045·5
Madras	..	2397·66	89	..	..	..	824·14	3360·64	42933·6
Rajputana	..	..	..	..	..	..	..	..	5·34
Central India	..	..	..	..	..	..	..	49·84	3609·84
Nizam's Territory	..	..	..	..	..	..	..	3438·96	25890·10
Mysore	..	..	..	..	..	..	..	186·9	6457·84
Calcutta	..	14·24	..	..	..	..	..	28008·3	121928·22
Bombay Port	81·8	1244·22	1009·26	..	..	..	..	45438·06	282357·84
Karachi	..	..	..	..	..	..	..	8515·52	31342·24
Madras Ports	..	617·66	3787·84	..	..	..	..	41132·24	359095·42
Total for September ..	2030·98	6635·84	6840·54	..	7·12	1892·14	824·14	150903·06	..
Total for 6 months, 1st April to 30th September 1933. ..	20685·38	46858·5	35623·14	635·46	21149·96	2107·52	30879·44	..	1121739·98

NOTE.—Maunds have been converted into cubic feet at the rate of 1 : 1·78 based on 1 ton = 50 cubic feet.

II.

Table showing Trade in Other Timbers between each Province and Indian State and Chief Seaport (in cubic feet) during the month of September 1933, and in the 6 months, 1st April to 30th September, 1933.

Articles and whence exported.	Imported into Provinces, excluding Seaport towns, into States and Chief Seaports.									
	Assam.	Bengal.	Bihar and Orissa.	U. P.	Punjab.	Sind and British Baluchistan.	C. P. and Berar.	Bombay.	Madras.	Rajputana.
OTHER TIMBER—										
Assam	..	45612·50	1936·64	..	..	..	..	..	..	..
Bengal	3451·42	..	16432·96	16386·68	710·22	..	427·20	..	..	..
Bihar and Orissa	108·58	95379·52	..	14213·30	..	..	..	..	30945·3	589·18
U. P.	..	19·58	11299·44	..	37768·04	3273·42	1940·20	3330·38	3·56	12059·5
Punjab	..	..	1·78	19533·72	..	26559·38	..	5·34	3·56	6717·72
Sind & British Baluchistan.	..	..	..	..	60094·58	..	..	..	..	37·38
C. P. and Berar	..	710·22	731·58	7851·58	3810·98	..	..	28887·62	2233·90	2330·02
Bombay	..	..	..	1559·28	..	..	32·04	..	1744·4	5124·62
Madras	..	..	..	..	49·84	..	..	339·98	..	5·34
Rajputana	..	..	..	19·58	85·44	..	..	153·08	..	..
Central India	..	..	..	6575·32	484·16	..	831·26	55·18	..	238·52
Nizam's Territory	..	..	..	..	..	..	..	313·28	2349·6	..
Mysore	..	..	..	939·84	..	..	..	..	2753·66	7·12
Kashmir	..	..	..	..	2014·96	..	..	..	..	..
Calcutta	375·58	10713·82	2872·92	464·58	834·82	..	19·58	..	74·76	14·24
Bombay Port	..	..	3·56	169·10	752·94	..	487·72	24 626·3	137·06	469·92
Karachi	..	..	..	..	1717·7	7598·82	..	..	..	112·14
Madras Ports	..	..	33·82	..	..	..	..	..	31287·06	..
Total for September 1933.	3935·58	152436·64	33312·70	67712·98	108323·68	37431·62	3738·00	57711·16	71532·86	27705·7
Total for 6 months, 1st April to 30th September 1933.	108341·48	1062496·2	442335·34	834366·1	1392527·82	382093·02	105416·94	1199543·78	703441·76	523012·06

NOTE.—Maunds have been coverted into cubic feet at the rate of 1 : 1·78 based on 1 ton = 50 cubic feet.

II.

Table showing Trade in Other Timbers between each Province and Indian State and Chief Seaport (in cubic feet) during the month of September 1933, and in the 6 months, 1st April to 30th September, 1933.

Articles and whence exported.	Imported into Provinces, excluding Seaport towns, into States and Chief Seaport.									
	Central India.	Nizam's Territory.	Mysore.	Kashmir.	Calcutta.	Bombay Port.	Karachi.	Madras Ports.	Total for September 1933.	Total for 6 months, 1st April to 30th September 1933.
OTHER TIMBER—										
Assam ..	..	..	..	..	5993·26	..	..	..	53542·4	436577·04
Bengal ..	..	..	..	..	45897·3	..	..	..	83305·78	823079·12
Bihar and Orissa ..	..	..	..	..	41680·48	..	..	2148·46	185064·82	1245375·22
U. P. ..	3650·78	..	..	..	12·46	..	534	..	73891·36	1871707·38
Punjab ..	176·22	..	..	3287·66	..	868·64	1844·8	..	58998·1	574731·74
Sind and British Baluchistan.	..	..	..	..	..	..	55·18	..	60187·14	65368·72
C. P. and Berar ..	10060·56	535·78	..	..	..	..	..	3777·16	60929·4	1450667·96
Bombay ..	2552·52	1359·92	..	..	..	7378·1	..	..	19750·88	383319·44
Madras ..	..	1536·14	11938·46	..	..	16·02	..	49359·40	63245·18	412703·68
Rajputana ..	147·74	..	..	..	..	30·26	..	..	436·1	40576·88
Central India ..	..	..	..	..	..	284·8	..	..	8469·24	175365·6
Nizam's Territory ..	80·10	..	1·78	..	..	140·62	..	..	2885·38	201535·16
Mysore ..	..	..	..	..	..	1062·66	..	2710·94	7474·22	138745·66
Kashmir ..	..	..	..	..	..	..	..	..	2014·96	11765·8
Calcutta ..	..	5·34	..	..	..	19·58	..	5·34	15400·56	163749·32
Bombay Port ..	190·46	528·66	94·34	..	..	..	..	7·12	27467·18	225848·18
Karachi ..	..	..	..	..	..	..	..	..	9428·66	54767·04
Madras Ports ..	..	..	808·12	..	..	..	..	..	32129	209858·44
Total for September 1933.	16858·38	3965·84	12842·7	3287·66	93583·5	9800·68	2433·26	58008·42	764620·36	..
Total for 6 months, 1st April to 30th September 1933.	281490·98	82597·34	81755·4	16279·88	712247·42	146673·78	4649·36	406473·68	..	8485742·38

NOTE.—Maunds have been converted into cubic feet at the rate of 1 : 1·78 based on 1 ton=50 cubic feet.

REVIEWS.

THE PHYSIOGRAPHY AND VEGETATION OF TRINIDAD AND TOBAGO,—A STUDY IN PLANT ECOLOGY.

BY R. C. MARSHALL, CONSERVATOR, TRINIDAD AND TOBAGO : CLARENDON PRESS, OXFORD, 1934.

The memoir which is divided into two parts contains six chapters and is well arranged and illustrated.

(1) Part I opens with the history and geography of the Islands. It treats briefly the chequered history through which the Islands have passed within comparatively recent times. The topography, geology and soils, climate and rainfall, temperature and humidity are all dealt with at some length. The graphic representations of temperature and humidity variations are extremely instructive. The information supplied with regard to clouds, winds, sun and atmospheric pressure is rather unusual in forest literature, and as such of pioneer interest.

(2) Part II commences with a description of various types of vegetation which are mainly based on moisture whether as rain, soil moisture, humidity or lack of adequate rainfall.

The number of ecological types within various kinds of tropical evergreen forests, containing as was to be expected hosts of species, has been kept within practical limits. In the transitional belts in which the character of vegetation changes gradually further subdivision may be necessary, but for all working purposes when a distinct type is discernible within a mile or two of another, the type division has achieved its purpose from the point of view of practical Forestry. The author is to be congratulated for avoiding a confusion which was bound to arise in a pioneer work of this type when dealing with tropical evergreen forests. The tropical semi-deciduous forest has also been dealt with in the same way.

The diagramatic representations of various kinds of forests and type sub-division give a very vivid idea of the classification.

The author's description of the destruction of tropical rain forests followed by regrowth of secondary vegetation and the formation of

deflected climax is full of interest. He draws a very ingenious distinction between deflected climax and deflected succession.

Chapter VI deals with zonation and succession. The soil moisture and rainfall is again the governing factor so far as zonation is concerned. The co-relation and gradual transition of mangrove forests through successive stages, such as herbaceous swamps, swamp forests and rain forest is well illustrated.

Chapter VII deals with Forestry, Agriculture and Land Allocation. The author has dealt with the subject rather briefly and though one may not entirely agree with the statement that " The natural forest may be said to express the integration of various climatic, topographical, and soil conditions obtaining in any given area," it can hardly be denied that such study can give valuable information for the eventual allocation of the land for agricultural purposes. Much will depend on the interpretation of the term "Natural Forest" and whether it has reached a stage of equilibrium and soil stability which adequately expresses all the locality factors—a question which is not easy to decide in the absence of detailed observation over a considerable period of time. The co-relation between forest and agricultural crops based on a study in plant ecology is fascinating and new, and it will receive an impetus from the publication of this memoir.

M. R. AHMAD.

ADMINISTRATION REPORT OF THE COCHIN FOREST DEPARTMENT FOR 1932-33.

Notwithstanding a very considerable restriction in the output of its more important timbers, teak and rosewood, the Cochin Forest Department has managed to show for the year an increase of over Rs. 12,000 in the net surplus revenue over the figures of the preceding year. This result was achieved by retrenchment and economy, by limiting exploitation to assured demand and by strenuous and successful attempts to clear old stocks. The passion for economy was, however, not allowed to interfere seriously with silvicultural measures.

During the year new teak plantations aggregating to 170 acres were made, the total area of teak plantations in the State rising to 3,450 acres at the end of the year.

The teak was raised under the *taungya* system on 120 acres, the field crop raised in conjunction with the teak being paddy. The results of this experiment are said to be promising, but its success and extension will depend on the harvests of paddy. The device of reducing costs by getting silvicultural work done by private agency in return for land or forest produce was extended to the case of cultural operations in deciduous selection forests. "The treatment of the area consisted in the removal, after careful marking, of all undesirable growth which it was either not worthwhile to retain or which interfered with the development of the more valuable species, climber-cutting, and supplementing natural regeneration by artificial planting of seedlings of superior species where the former were lacking or deficient. The working of the first coupe on these lines was entrusted to one of the experienced contractors who undertook to do the work free of cost in lieu of the sale to him of the timber resulting from the improvement fellings at concession rates, *viz.*, the ordinary seigniorage for timber and 8 annas per cartload of fuel." It is not so easy perhaps in other parts of the country to find contractors willing to relieve forest officers of the work of carrying out these different measures. One may however question the wisdom of thus directly introducing commercial interests in what ought to be essentially silvicultural measures, and one may doubt the soundness of the policy of "entrusting" such technical works to unskilled agency. This experiment in Cochin will be watched with interest.

Departmental extraction of teak fell from 3,117 candies* in 1931-32 to 264 candies in 1932-33; while the extraction of rosewood fell from 448 candies to 356 candies. Elephant capturing operations were not undertaken during the year. The forest tramway, an important means of transport, continued to work satisfactorily. The gross revenue for the year was Rs. 2,97,117, the expenditure Rs. 1,63,975, and the surplus Rs. 1,33,142.

* NOTE.—Candy is equal to 10 c.ft. of timber.

A point of interest is the attempt made to demarcate permanently the frontier boundary by putting out tamarind plants.

C. R. R.

REPORT OF FOREST ADMINISTRATION IN THE ANDAMANS, 1933-34.

The Inspector-General of Forests toured in Andamans in February 1934 and prepared an Inspection Note dealing with questions of forest policy and the technical details of the new working plan ; these matters have been under the consideration of the Government of India and since the close of the year orders have been passed approving generally the policy therein laid down. The Andamans have had a successful year although trading conditions have been difficult. The imposition of an excise duty on matches resulted in the cancellation of orders for match logs and the full effect of this excise duty cannot as yet be gauged. It is unfortunate that as the excise duty is merely on quantity the expensive matches made of imported aspen are favoured at the expense of cheaper article made of Indian timber. The enumerations and survey for the new working plan were completed during the year and the Inspector-General visited the areas under regeneration and satisfied himself that the methods employed have been successful. This is really the first effort which has been made to obtain successful natural regeneration in the Andamans and the results are excellent. The new working plan will prescribe the carrying out of similar operations over an extent of country sufficient to maintain the yield capacity of these valuable forests. It is to be regretted that on the 1st of May 1933 a contractor was shot dead by the Jarawas while employed on forest exploitation and a further attack was also made on the 28th resulting in the death of a bush policeman. Forest work was going on far away from what is known as the Jarawa area and such an attack was entirely unexpected. The Bonington Mill remained closed during the year and work was continued only at Chatham where 10,046 tons were sawn up as compared with 10,676 tons in the previous year. Details of the export of timber of all classes as compared with the

previous year are as follows :—

	1933-34.			1932-33.		
	Logs.	Squares.	Scantlings.	Logs.	Squares.	Scantlings.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
Calcutta ..	3,614	1,002	4,926	4,379	769	5,752
Madras ..	180	..	2,652	1,003	..	2,131
Rangoon ..	5,383	..	..	7,361	..	..
London ..	..	470	592	81	214	676
Other Markets	151	3	..	..	15	137
Total ..	9,328	1,475	8,170	12,824	998	8,696

In view of the preliminary calculation of the yield made for the new working plan it appears that no great increase in the outturn of timber can be looked for and that some reduction in the present over-head charges should be affected. The revenue realised during the year was Rs. 14,01,064 and the expenditure Rs. 10,96,756, leaving a cash surplus of Rs. 3,04,308, which in these difficult times may be considered satisfactory.

C. G. T.

EXTRACTS.

THE PROBLEM OF "OVERHEADS."

ARRIVING AT ACCURATE APPORTIONMENT OF COSTS.

BY "FIGURE MAN."

At one time there was something vague about the word "overheads," but we have come to understand much more about all that it stands for. It is a kind of common meeting-ground for the economist, the costing engineer and the accountant, since all have a claim to say something about overhead expenditure—each from his own particular point of view.

The subject of overheads is growing in importance every day in industry and figures largely in its daily problems. How can overheads be further reduced? How far can they be reduced without danger to production and efficiency? It should be understood that large-scale production will reduce the percentage of the overhead

charge upon *each unit*, but the benefit of this can only be felt when the whole plant is working at full capacity. When certain plant or machines become idle, the overhead charges " creep-up " as a percentage on reduced output.

The value of a machine lies in the fact that it can turn out *more work* in an hour (let us use this unit of time) than a person can do who relies entirely upon his hands. More often than not the machine work is much more accurate, particularly for small units.

But having installed the machine, and very frequently this is a heavy capital outlay, we cannot " pay it off " when we have no work for it to do, the same as we can with workpeople. When the machine is working regularly at full capacity, we have every chance of doing well with it, but should we have occasion to run it for one day only, each week, then each unit of output will bear a very heavy overhead charge. If we had 80 people working for us instead of the machine, we should adopt the usual method of paying off, perhaps, 60 of them. Thus we would save the wages of 60 people each week, but we cannot adopt this method with machines.

If we have paid £5,000 for a set of machines or for a particular plant, we must consider this heavy lock-up of capital upon which we may be forced to pay 7½ per cent. Another point to consider is that having purchased a machine that has been designed to do certain work, we cannot very well use it to do something different—if we find that there is *now* no demand for the goods which the machine was originally designed to turn out.

Behind the workmen and their specialised machines, we have our factory organisation, which draws heavily, each day, for its expenses. Foreman, supervisors, technical men, rate-fixers and costing clerks have all to be paid and paid at a heavier rate than the workmen. No matter if half the machines of a factory are idle, very few firms like to part with their administrative or technical staffs, neither do they care to reduce them—for a few months, at least.

Thus it can be readily understood that a factory with 60,000 superficial feet of floor space cannot be saving much in overheads if it shuts down 25,000 feet of its productive floors.

No power or lighting may now be supplied to that part of the factory, but if the factory supplies its own power and light, that reduction will make no difference to the staff in the power and lighting section. We may apply this to every other section of the factory coming under the head of overheads.

Prime Cost and Oncost.

Overhead costs or overhead charges are usually defined as those expenses of an indirect nature which the organisation incurs *beyond* that expenditure for prime cost. Again, prime cost is that which is expended for materials and wages upon a definite job ; for example, wood in the making of doors or windows and the wages of the men who make these articles. Now, if we do not want any more doors and windows for the next four months, then we can save the material and the wages paid to the men ; these are the direct charges or components of the prime cost.

But we cannot save much on the indirect charges or the oncost or overheads, so that they fall more heavily upon the reduced output.

From the usual accountancy point of view, when dealing with the financial transactions of a business, exact amounts are known. If the invoice for £800 worth of timber is received and the wood is also received into stock, we are dealing here with transactions involving an exact amount. There are no estimations to make; the quantity of wood bought has a definite value in money, as stated.

If a workman works 48 hours at the agreed normal rate of 2s. per hour, and 8 hours at 2s. 6d., we can calculate his wages to an exact amount, just the same as with the timber; but there are some things that have to be estimated.

Let us suppose that in the making of doors and windows, for instance, we have used, over a period of six months, timber, etc., as direct materials, to the value of £5,000, and that we have paid in wages the sum of £10,000. We must now find the total cost of our overheads during that period and must distribute this oncost in the most accurate manner possible. Let us suppose that the oncost is £4,000.

Now how are we going to charge the oncost in order to fix the right proportion of this £4,000 upon each door and window?

We may take the labour basis first; the oncost is £4,000 and the total wages paid is £10,000. Therefore, for every £1 paid in wages, 8s. goes for overheads. If, therefore, the labour cost on a certain job amounts to £100, then we must add £40 for works oncost and office oncost, which expenditure is often classed under the heading of overhead costs. Here we have a kind of working formula; quite an easy one, but probably not very satisfactory in *all* cases.

We have further supposed that two different articles are made—doors *and* windows—and before we can feel confident about our costs we must try to find out the separate values of the labour and the material in both articles. For the last six months we have our figures in total as given above, and if we had been making doors *only*, then no difficult calculations would arise; the same if we made windows only.

How many windows have we made and how many doors? What is the value of the labour spent on each? What is the value of the material in each, or to put it more accurately still, what is the value of the wood required to make a door? Now another point—doors and windows vary in size and design, and if we are not making a standard size and design, then we are getting into further difficulties. All this arises in our efforts to apportion our overhead charges so that we may be able to say with mathematical exactness that a certain type of door, of a certain size, has cost us:

Prime cost			labour	49·00
			materials	22·00
				71·00
Overhead Costs	Works oncost	..	20·00	
	Office oncost and Distributive expenses		9·00	29·00
	Total cost	..		100·00

The above workings are on a percentage basis and may relate to any article made.

(*Timber Trades Journal, 9th June* 1934.)

MINIATURE FORESTS : A NEGLECTED EDUCATIONAL OPPORTUNITY.

Due to the lack of examples of forest management not only forest owners and other recipients of extension work, but professional foresters and forest students as well, have difficulty in visualizing forestry. They have difficulty in picturing a normal forest, or even an organized forest under sustained yield management. It is often difficult to illustrate properly the sequence of silvicultural systems. The European forester generally excels the American in ability to visualize the possibilities of a stand or forest ; he can see in his mind's eye how a given stand would look if managed for greatest productivity ; he can see how reproduction cuttings would be arranged under different systems. This capacity is developed not only by having seen examples of forestry, but by the character of training. It ought to be obvious that ability to visualize the goal is of the highest importance for the practical forester. Easily observable demonstrations would have the greatest educational value and widest application.

A full-sized demonstration forest has come to be, one might say, standard equipment for many forest schools and extension services. This feature is of the utmost value ; on many occasions small indoor exhibits have been arranged. The miniature forest is proposed not as a substitute for either, but as a demonstration at minimum cost and use of space of an actual growing forest, where every factor operating in a full-sized forest can be observed, although not perhaps in the same relative scale. The procedure would be as follows :—

On a small plot of ground, preferably near the forest school buildings or other institution, small trees would be set out to represent a given type of forest. " Mature " timber could be represented by trees of Christmas tree size or smaller if desired, and reproduction by seedlings. Each " stand " should be large enough to stimulate stand conditions and appearance. One plan would be to plant (or sow) a small area, say the size of a nursery seedbed every year. If our oldest forest schools had started plantations of this sort when founded there would be now miniature forests of small even-aged stands compact enough to be visible from one point, whence the observer could take in the entire " forest " at one glance. This is not possible in most cases at least, with full-sized demonstration forests of several hundred to a few thousand acres in extent. The miniature forest might well occupy one acre or less. Trees could be harvested at Christmas tree size. Plantations should be made as close as transplant beds and thinned often. Short-needled conifers, and small-leaved hardwoods should be used so that the proportion of leaves to trunk size would approach more nearly that of mature trees. The small area would make this quite feasible, especially since much of the work could be done by students in the course of instruction. An illustration of clear-cutting and planting system has been given. Other reproduction methods could be arranged similarly and perpetuated by direct seeding or planting seedlings.

The miniature forest would be excellently adapted to illustrate management. Compartments and stands could be delineated by boundaries consisting of telegraph wire enamelled in different colours supported on short stakes. One colour could represent

compartment boundaries and another sub-compartments. All stands should bear appropriate labels. The chief way in which the forest would differ from a full-sized forest would be in respect to age classes. No 100-year trees could find room. The solution would be to designate a single even-aged stand of seedlings, for example, as 0-10 years; 2-1 transplants could serve as 11-20 years, etc. Mixed stands could be created as well as pure.

Summary.—The miniature forest is proposed as an educational demonstration of sustained yield forestry. By such a plan operations not possible on a large scale due to economic conditions can be illustrated. A bird's-eye-view of the forest as a whole can be obtained from one point. The expense connected with such a project would be relatively small; yields from thinnings might be used to fill in existing plantations; final cuts could find use as Christmas trees or fuel. The amount of such cuts would be small and easily marketed. The miniature forest could be established in connection with a forest nursery. Where the topography is suitable logging improvements, roads, trails, lookout towers, etc., can be developed in miniature. The miniature forest would be a going concern, a realistic model of conditions on a large scale. growing, subject to fire, insect and fungus damage much as in a full-size forest, an ideal which could be visualized by every observer. -*Henry L. Baldwin, Pennsylvania State College.*

[*Editorial Note.*—Perhaps miniature forests have not been neglected quite as much as Dr. Baldwin indicates. The University of Washington has a splendid miniature forest at Chas. Lathrop Pack Forest. The Cloquet Forest Experiment Station has been planning a miniature forest for several years and has the plot of ground all ready to go ahead with it this spring. Presumably other forest schools have given some thought or taken some action on the establishment of a miniature forest.]

[*Journal of Forestry* (*U. S. A.*), *November* 1933.]

WATER SUPPLIES AND EMERGENCY LEGISLATION.

When we wish to determine the relation between the rain falling on an area, and the volume of water delivered by the stream draining that area, we are faced with a problem as yet unsolved. The geological, physical and meteorological conditions of river catchment basins are so varied that a search for mathematical expression connecting "yield" from rainfall appears to be in vain.

The simplest and most accurate method for such determination is, as suggested in the leading article in *Nature* of April 28, by the actual measurement of stream flow for a considerable number of years, so as to ascertain the mean, the maximum and the minimum flow that may be expected; and also the variation of stream flow during the seasons of the year. Comparing the results so obtained with the rainfall during those years, we may be able to deduce with some reasonable accuracy stream flow in years in which rainfall records are available, and stream flow gaugings are not.

Observations of stream flow in Great Britain have been neglected, and the same remark applies to observation of water levels in our wells. Some years ago the British Association laid down a series of questions in regard to wells which appear to have been lost sight of. It is possible that the limited funds allotted for investigations of this nature curtailed the information collected.

The heavy rains of 1927, the disaster of January 1928, and the following wet years caused the country to be more concerned with floods and arterial drainage, than with drought, leading to the appointment of the Royal Commission of 1927, and the passing of the Drainage Act of 1930, and so to the formation of Catchment Board, with the result that schemes for widening and deepening our rivers and carrying off the rainfall as quickly as possible are under consideration.

Speculative building on riparian lands subject in former years to flooding at very long intervals, are now more frequently flooded, due to the increased flow from drainage of lands, permeable areas and arterial roads, and this has increased the demand for a more rapid carrying away of flow due to rainfall.

The problem that now faces the country is the preservation of our springs. Most of our rivers derive their dry weather flow from springs, the only source of supply of which is the percolation of our winter rains to the ground water plane of saturation; and instead of widening and deepening our rivers to pass off extraordinary floods quickly the flood water should be allowed to spill over the river margins so that as the flood slowly subsides, the water is enabled to percolate into the subsoil. One other suggestion I would make, is a return to Mr. Joseph Elkington's "sink hole drainage." That is, instead of passing off rain-water from whatever sources it may be received into streams and thus swell our rivers, it is passed into "soakage pits" or "absorbing wells" placed at suitable intervals and sunk to permeable areas, and thus to pass the rainfall to ground storage.

The Catchment Boards, I would suggest, should now confine their activities to the measurement of stream flow and its correlation with rainfall; to carry out the requirements of the British Association in regard to riparian lands subject to periodic flooding, so as to reserve them for pasture or agriculture, and to prevent speculative building thereon.—J. M. LACEY.

(*Nature*, 12*th May* 1934.)

SUMMARY OF GONDA WORKING PLAN, 1933-34 to 1947-48.

(*Working Circle I—The Tikri Sal Clearfelling Working Circle.*)

To this Working circle have been allotted all the *sal* forests of the Southern Forest. The Silvicultural system will be clearfelling with artificial regeneration of *sal*, using *taungya* wherever possible. The rotation will be short so as to supply the principal demand for small size timber poles and fuel. This working circle will supply grazing for 650 cattle of forest villages and others. The area of this working circle is 13,356 acres. This is practically the same as the *sal* W. C. under Marriott's plan for the Tikri Forest except that regeneration under his plan was natural from coppice, and under this plan is artificial, by *taungya* as far as possible.

Working Circle II—The Jamun Working Circle.

To this working circle all the *jamun* belts of the Southern Forest have been allotted. The system to be employed is clearfelling with regeneration from coppice shoots. The produce will consist of poles for building purposes and fuel, for which there is a great demand. The area of this working circle is 336 acres. This is a continuation, without change, of the prescriptions of the last plan.

Working Circle III—Bhambar Sal Clearfelling Working Circle.

To this working circle have been allotted all the *sal* forests of the eastern portion of the Northern Forests which are situated on the level ground suitable for working on the *taungya* system for obtaining artificial regeneration of *sal*. Part of this working circle will be opened to grazing. In those areas where good established regeneration of *sal* is present, this will be utilised and the remaining standards removed. Elsewhere artificial regeneration will be the rule. A long rotation for large size timber production is fixed. The total area of this working circle is 3,621 acres. Of the 3,621 acres, 294 acres are excluded from all calculations of the yield and all the other prescriptions of the working circle, and will receive special treatment to attain complete regeneration during this plan if possible. After regeneration, the area will come under the ordinary prescriptions of this working circle. This working circle comprises all the flat areas allotted to the Conversion W. C. in the last plan. Artificial regeneration on the *taungya* principle is prescribed in this plan, in place of natural seedling regeneration to be obtained by regeneration fellings laid down in the last plan.

Working Circle IV—Sal Selection-cum-Improvement Working Circle.

To this working circle have been allotted the predominantly *sal* areas of the eastern portion of the Northern Forests not included in Working Circle III, and all the predominantly *sal* areas of the western portion of the Northern Forests. Only 50 per cent. of *sal* over fixed diameter limits will be removed, and thinning will be carried out among the smaller diameter classes so as to ensure good growth of the best trees. No grazing will be allowed anywhere in this working circle but some timber for concessionists may be supplied. The demand here is for large-sized timber as there is a long lead to railhead ; therefore, as large diameter limits as are economically sound have been fixed. As the soil quality varies and as the distribution is in two widely separated tracts, two felling series have been made, with different diameter limits. In each felling series two quality classes are considered, with different diameter limits for each. The area of this working circle is 27,785 acres.

This working circle carries on the prescriptions laid down for the *Sal* Selection and Improvement W. C. of Tulsipur Forests by Stewart and *Sal* Selection and Improvement W. C. of Sohelwa Forest by Stephens, with an increased diameter limit for the Tulsipur part, a restriction that only 50 per cent. of the selection trees may be removed, and the addition of those areas of the old Tulsipur Uniform Sal W. C. of Stewart's plan, which are on broken ground unsuitable for *taungya*.

Working Circle V—The Miscellaneous Clearfelling Working Circle.

The object of management here is to replace the present crop of mixed valuable and valueless species with the most valuable crop silviculturally suited to each area. The only system possible for bringing this about is a system of clearfelling with

artificial regeneration preferably on the *taungya* system. Therefore only areas on good level soil have been included in this working circle. As large an area as possible in each of the eight felling series of this working circle will be clearfelled and given over to *taungya* each year. Certain limits of area have been fixed but it is not expected that these can be worked up to in most cases on account of difficulty in obtaining labour. It is this labour difficulty which has necessitated the formation of so many felling series.

Approximately 21,000 acres of this working circle are open to grazing. The total area is 27,348 acres. This working circle is composed of all the miscellaneous forest of the Tulsipur reserve suitable for *taungya* and is drawn principally from the better forests allotted to the Conversion to Uniform W. C. in Stewart's plan, and the only change is the substitution of artificial regeneration of more valuable species for natural regeneration of available species. Some few areas are of poor quality but on culturable land. These were treated on the Selection system under the last plan.

Working Circle VI—Miscellaneous Selection and Improvement Working Circle.

To this working circle are allotted all the more valuable miscellaneous forests of the Northern Forest which are situated on ground unsuited for *taungya* and so could not be included in Working Circle V. 50 per cent. of trees of valuable species over certain fixed diameter limits will be removed on the selection system, while thinning will be done at the same time so as to aid development of the best trees of the most valuable species occurring in any one place. No grazing will be permitted in this working circle except in parts of Felling Series I (Sohelwa). The total area of this working circle is 31,529 acres. This is composed of :—

(*a*) The better quality areas allotted to the Selection and Improvement W. C. under Stewart's plan, it continues the prescriptions but limits the removal of selection trees to 50 per cent. and decreases the cycle from 20 to 15 years.

(*b*) The better quality areas allotted to the Selection and Improvement Miscellaneous W. C. under Stephen's plan ; it continues the prescriptions but increases the cycle to 15 years and only 15 per cent. of the selection trees to be removed.

(*c*) The whole of the *jamun* coppice and *sissu* standards W. C. with the exception of one compartment, which had been almost entirely clearfelled and which will now receive special treatment.

Working Circle VII—Miscellaneous Protection Working Circle.

To this working circle are allotted all the miscellaneous forests which contain very few valuable species, and wherever there is a serious danger of erosion. No work will be done in this working circle except the removal of stems for concessionists where the removal of these stems would be to the advantage of the crop. Grazing will be permitted in those compartments detailed in Appendix I, where there is no imminent fear of erosion, amounting to a total of 16,280 acres. The areas allotted to this working circle are drawn from all the poorest class areas allotted to the Miscellaneous and Grazing W. C. of the old Sohelwa plan and the Miscellaneous Selection and Improvement W. C. of the old Tulsipur plan.

Working Circle VIII—The Khair Working Circle.

This working circle overlaps all the working circles of the Northern Forests and consists of *khair* trees wherever they occur in sufficient quantity, except in Working Circles III, IV and P. B. I. of Working Circle V. The system is that of simple selection, all *khair* over a fixed diameter being removed.

The approximate area of this working circle, which overlaps the working circle is 28,000 acres. This is a new working circle. In the last plan *khair* was worked under the ordinary rules of the working circle in which it occurred. It is anticipated that the institution of pure *khair* coupes will greatly increase the revenue from this source.

In general the main points of the difference between this and previous plans are :—

(1) The substitution of artificial regeneration on the *taungya* principal for natural seedling and coppice regeneration wherever this is possible.

(2) The limiting of cultural operations to :—

(*a*) Concentrated cleaning and climber cutting in one compartment of old (the Bhambar Clearfelling) W. C.

(*b*) Climber cutting by marking gangs only.

(*c*) Cleanings (free of cost) in *taungya* plantations.

INDIAN FORESTER,

FEBRUARY, 1935.

FORESTS AND PUBLIC RIGHTS.

The Revenue Officer is ever anxious to secure the rights of the communities living near and in the forests. As a forest settlement officer, he is supposed to adjudicate between the claims of the people and that of the Government as represented by the Forest Department. He is particular that every semblance of a right is secured to the claimants. But does he really secure them their rights for ever. Very often he is a blind enthusiast in the cause of the countryside. We have had an occasion to discuss the protection of forests with a very senior revenue officer who emphatically declared that if it was necessary to disforest the whole of the district forest area for the benefit of the people, he would not hesitate to do so. While his enthusiasm in the cause of the civil population was praiseworthy, his blindness to see things in the right perspective was pitiable. He cannot be blamed altogether, for he had never known that the prosperity of the countryside primarily depends on some sort of soil covering. There are numerous instances in this country and abroad that depopulation and poverty have followed destruction of forests as naturally as night follows the day. This has happened in many countries in the past, is happening in the United States at the present day, and is imperceptibly happening in many provinces in India even now. But how many have eyes to see things as they are. What is the remedy? Either the civilian must have a thorough grounding in the general principles of forestry or the forest officer must be employed to do the work of the revenue officer in forest areas. Why cannot the Government of India provide for such training to the civilian while he is under probation as is already done in the case of

the colonial Civil Service or include such a course during his practical training in India. Facilities for such instruction are available at Oxford and no doubt could be arranged at other British Universities. The Punjab did make an attempt to do something in this direction by asking the Forest Department to arrange to deliver a couple of lectures to young Civilians, which we believe, were well received, but this was hardly enough. A great deal has been written in the pages of the *Indian Forester* on the topic of erosion and denudation, the most terrible examples of the results of forest destruction are there for everyone to see; Commissions have sat and papers have been prepared, enormous files have been compiled and yet the lessons we have preached for fifty years have hardly yet been learnt and every new recruit has to be tackled afresh—many never come in contact with forest problems for years and are then called on to decide matters of which they can have no knowledge. The townsman knows nothing of the forest, the Indian villager regards it as something to loot, and the politician is mostly concerned with votes. So the forest covering of the hills is destroyed to make way for the goat, the soil is washed away, torrents eat up the cultivated plain, the wells dry up and the fairest regions of the earth become a desert.

REGULATION OF THE SELECTION YIELD

By

E. A. Smythies, I.F.S.

1. Champion, in his valuable report on the All-India Sal enquiry (I. F. R., Vol. XIX. part III), stresses again and again the importance of safeguarding the future yield of exploitable or selection trees. Reference is made to this matter in his "Suggestions for future management," and the point is further stressed in his general conclusions (page 138) as follows :—

> "31. Control in unevenaged forest should aim at the maintenance of the yield in sound trees of the exploitable diameter, except

that adjustments should be made for present obvious excess or deficit of such trees.

32........Information is required concerning the relative proportion of the diameter classes to be aimed at."

This point of management is evidently of the greatest importance, affecting practically every province and every important sal forest in India, and equally it is evident from Champion's report that it has not infrequently received inadequate attention in past Working Plans.

At the recent Silvicultural Conference at Dehra Dun where representatives of all Provinces and many States were present, the importance of statistical research in mixed irregular forests, with a view to collecting data for yield prescriptions in Working Plans, was clearly recognised. It was emphasised by a number of provinces as one of the chief items for co-operative work, and an important resolution was passed after an interesting discussion and debate.

This is my excuse and justification for returning again to a subject which I have already discussed in the *Indian Forester* (1933, pages 3—12, 411—434, 659—664). This article should be regarded as a continuation of the three previous articles.

2. In several cases mentioned above, Champion refers to the "U. P. method of control." This method of control is still in process of being worked out in theory, and has now been adopted in one important working plan in these provinces, but it has not yet been tested by practical experience. But the theory underlying this method of control of the selection yield may be briefly explained, so far as it has developed up to date. The underlying principle is defined by Champion in item 31, page 138 of his report, which is quoted in para. 1 above. The equation $x=f/t$ (II—z % of II) gives us the measure of recruitment of selection trees from the next lower diameter class (*vide Indian Forester*, 1933, page 661) and forms the basis of the safeguarding formula (*vide Indian Forester*, 1933, page 664), the actual yield, however, being prescribed as a percentage of the exploitable trees found in the area coupe of the year, and this percentage is calculated on the formula $\frac{x}{1+\frac{x}{2}} \cdot 100 \pm A$

The essential difference between this and other formulæ (such as Brandis or the Burma method) is that the annual yield is a percentage of I class trees found by the marking officer and not a yield of volume, basal area, or number of trees.

3. Champion has further emphasised (in item 32, page 138 of his report, also quoted in para. 1 above) the importance of the relative proportion of the diameter classes to be aimed at. It is possible to calculate the distribution of diameter classes which guarantees that the total loss in each diameter class, from all sources, during a felling cycle is balanced by trees passing up from the next lower class, thereby keeping the number constant. This will assure the present yield of selection trees indefinitely. Adopting the same symbols as in previous articles :—

I = the number of stems in the selection class (in hill sal forests, usually 20″ diameter and over) at the time of Working Plan enumerations.

II = the number of stems in the next lower diameter class (usually 16″—20″).

III = the number of stems in the next lower diameter class (usually 12″—16″).

f = felling cycle.

t, t^1, t^2 = the time taken for the II, III, IV diameter classes to pass to the next higher class.

z, z^1, z^2 = the fraction (not percentage) that disappears or does not pass up in t, t^1, t^2........years.

By the application of my safeguarding formula (*vide Indian Forester*, 1933, pages 423 and 662), the loss of I is *ex hypothesi* replaced from II, since the loss of $I = x = f/t\ II\ (1-z)$

$\therefore II = x\ t/f\ (1-z)$, and the total loss from II in f years= $x + f.z.II/t = x + xz/1-z$.

$\therefore$ III has to supply $(x + xz/1-z)$ II class trees in f years to keep II constant.

$\therefore (f/t^1).III\ (1-z^1) = (x + xz/1-z) = x/1-z.$

$\therefore$ III $= x\, t^1/f\,(1-z)\,(1-z^1)$

$\therefore$ the ideal proportion of II : III to give constant yield of I is— $x\, t/f\,(1-z) : x\, t^1/f\,(1-z)\,(1-z^1) = t : t^1/1-z^1$. Similarly the ideal distribution of all diameter classes to ensure a sustained yield of I is— $t : t^1/\,1-z^1 : t^2/\,(1-z^1)\,(1-z^2) \ldots . t^n/\,(1-z^1)\,(1-z^2) \ldots . (1-z^n)$ (*a*) If for a first approximation, we assume $t = t^1 = t^2 \ldots .$ this formula simplifies to— $1 : 1/1-z^1 : 1/(1-z^1)\,(1-z^2)$ .. .. .. (*b*) A second assumption that $z = z^1 = z^2$ still further simplifies the formula to— $1 : 1/1-z : 1/\,(1-z)^2$ .. .. (*c*) These three modifications of the same formula enable us to calculate mathematically the distribution of diameter classes which will sustain the present growing stock and yield of selection trees. I believe that either (*b*) or (*c*) will give a sufficiently accurate first approximation for the top 3 diameter classes until such time as statistical research gives us some reliable data for our irregular hill sal forests. Although the mathematics to arrive at the formula may look rather complicated, its actual application to our irregular forest conditions is comparatively simple. Thus in the simplest form (*c*), if we take $z = z^1 = z^2 \ldots \ldots = 1/4, 1/3, 2/5, 1/2, 3/5$, we cover the following theoretical distribution :—

Values of z	I class.	II class.	III class.
1/4 or 25%	9	12	16
1/3 or 33%	4	6	9
2/5 or 40%	9	15	25
1/2 or 50%	1	2	4
3/5 or 60%	4	10	25

We can compare the theoretical distribution thus calculated with our actual ditribution, as shown by enumerations, to get some rough idea at least of abnormality. The main difficulty at our present stage, and one which has led to a good deal of thought and correspondence, is what value to take for z in the above table.

4. Reliable data for t and z can, I believe, be obtained comparatively quickly (*i.e.*, compared to data for an irregular yield table), and we are taking the necessary steps on a large scale. These include :—

(*i*) Large scale enumerations, a careful record of all trees felled in each diameter class over a period of 15 years, and then re-enumerations.

In two years 1933 and 1934 all sal 12″ and over have been enumerated in parts of two Divisions, over nearly 250,000 acres.

(*ii*) Detailed linear sample plots in mixed irregular forests. During the past season about 13 miles have been laid out, and this work will be continued for two or three years.

After 15 years these measures should give adequate data for t and z for each diamater class ; for the present we have to assume values which we believe to be conservative, and with revision and re-enumerations in 15 years' time no great harm is anticipated if the assumptions are not absolutely accurate.

5. Without waiting for these statistical data we can possibly fix z for the II and III classes now within definite limits. For example, our actual markings of II and III classes in past coupes of hill sal forests give a figure for z about 14% or 1/7th, but we know that thinnings in these classes have been very cautious and also that a certain number of stems stagnate or die out without being felled in the 15 years felling cycle. Hence a minimum figure for z will probably be 20 or 25% (1/5th or 1/4th).

Similarly a maximum figure for z can be obtained by a consideration of the volumes of these diameter classes. Volume tables and long experience have proved that the outturn per tree in each diameter class is approximately in the ratio 12″-16″ : 16″-20″ : 20″-24″ = 1 : 2 : 3.

Therefore out of 3 II class trees if only 2 pass up to I class, (corresponding to $z = 33\%$ or 1/3), the volume of this II class as a whole will not increase, *i.e.*, *there will be no nett volume increment.* Similarly if $z=50\%$ or 1/2 for the III class, there will be no nett volume increment in that class. This is highly improbable, if it were so, we should be dealing with a forest where a 20″ exploitable diameter would be difficult to justify without a very large price increment. We may take it therefore that the II and III classes do not decrease in volume when passing up to the next higher class, and therefore z must be not greater than 1/3 for II and 1/2 for III. This fixes our possible limits for z, *i.e.*, for II between 1/5 and 1/3 and for III between 1/4 and 1/2.

Some indication of what these extreme limits mean in terms of trees may be given. If, for example, we aimed at 50% removal of I class trees in a 15-year felling cycle as reasonable from the point of view of both silviculture and management then the ideal distribution of the diameter classes to ensure this would be within the following limits :—

(*i*) with the minimum values for z

$$\begin{aligned} \text{I : II : III} &= 1 : \frac{1}{1 - 1/5} : \frac{1}{(1 - 1/5)\ (1 - 1/4)} \\ &= 1 : \ {}^5/_4 \ : \ {}^5/_3 \\ &= 1 : \ 1{\cdot}25 \ : \ 1{\cdot}67 \end{aligned}$$

(*ii*) with the maximum values for z

$$\begin{aligned} \text{I : II : III} &= 1 : \frac{1}{1 - 1/3} : \frac{1}{(1 - 1/3)\ (1 - 1/2)} \\ &= 1 : \ 1{\cdot}5 \ : \ 3 \end{aligned}$$

If the actual distribution falls outside these limits, it must be abnormal.

6. We may look on this point in another way.

If v_2 = the present volume of the average tree 16″-20″

v_1 = volume of the same tree in t years time, *i.e.*, the volume of the average 20″-24″ tree.

Then the volume increment % p. a. of the 16″-20″ class =

$$\frac{(v_1\ (1-z) - v_2)\ 100}{v_2\ t}$$

Suppose further there is a price increment as the trees pass up beyond the selection limit, and

p^2 = the price per c.ft., or per volume unit of the 16″-20″ class.

p^1 = ditto of the 20″-24″ class.

Then the price increment % p. a. of the 16″-20″ class =

$$\frac{(v_1\ p^1\ (1-z) - v_2\ p^2)\ 100}{v_2\ p^2\ t}$$

This formula gives the rate of interest on our 16″-20″ capital, and hence a measure to estimate or judge the correctness of the 20″ selection limit. Using this formula, and taking t =30 years, v_2 =2 volume units, and v_1 = 3 volume units, we obtain the following table for a wide range of different values for z and for the ratio $\frac{p^2}{p^1}$

$\frac{p^2}{p^1}$	z = 1/5	1/4	1/3	2/5	1/2	3/5
1/2	4·67	4·17	3·33	2·67	1·67	0·67
2/3	2·67	2·29	1·67	1·17	0·42	—0·33
3/4	2·00	1·67	1·11	0·67	0	—0·67
4/5	1·67	1·35	0·83	0·42	—0·21	—0·83
5/6	1·47	1·17	0·67	0·27	—0·33	—0·93
1	0·67	0·42	0·00	—0·33	—0·83	—1·33

Note.—Below the continuous line, the rate of interest is 0 or negative, below the dotted line it is under 1 per cent. The former certainly and the latter probably would necessitate a reduction in the selection limit.

Further, the low values in the bottom line, where there is no price increment, show that a price increment is practically essential to justify a 20″ selection limit wherever t = 30 years or more. This has, I think, possibly not been realised hitherto in the management of U. P. sal forests. A high rate of interest is not expected in growing large timber, and there are other reasons why Government should grow large timber, *e.g.*, to meet the Railway demand for bridge and crossing sleepers, but this policy cannot be regarded with equanimity if it

means that the reward for nursing up the 16″-20″ class for several decades is a rate of interest which is negligible or even negative.

7. A concrete example will perhaps illustrate better than a verbal description how the formulæ might be applied in practice in the management of our irregular sal forests.

(*i*) Enumerations of 50,000 acres of Ramnagar Hill Sal Working Circle give the following figures of diameter classes :—

I = 91,000

II = 1,53,000

III = 3,07,000

(*ii*) It is estimated that 10% of the II and III classes is such poor quality (IV) that the trees will never reach the 20″ selection limit. Allowing for this, the distribution of the three diameter classes may be taken as I : II : III=91,000 : 1,38,000 : 2,76,000

= 1 : 1·5 : 3

(*iii*) Applying the safeguarding formula, with

$f = 15,\ t = 30,\ z = \frac{1}{3}$, we get

$x = \frac{15}{30}\ (1{\cdot}5 - {\cdot}5) = \frac{1}{2} = 50\%$ of I.

(*iv*) Applying the distribution formula.

The ideal distribution of I : II and of II : III to sustain the selection yield is

$1 : \frac{1}{1-z} = 2 : 3$

The actual distribution of I : II (=1 : 1·5) is therefore correct.

The actual distribution of II : III is 2 : 4, *i.e.*, there is an excess of III.

8. I will give one more example to show how the control would function with a more abnormal distribution of the diameter classes. Enumerations of 30,000 acres in Jaspur Range showed I : II : III= 1 : 2·5 : 6·0.

The proportion II : III =2·5 : 6 is beyond the maximum figure for z, and hence III is excessive relative to II. But the proportion I : II =1 : 2·5 is also beyond the maximum figure for z, hence II is

also excessive relative to I. Or putting it the other way, I is very much in deficit compared to II and III, and must therefore be increased, which is assured by putting a minus value to A in the formula. Silviculturally also this would be necessary, for taking (as usual) $f = 15$, $t = 30$, $z = 1/3$ the formula gives $y = 83\%$ of I, which we know would never be silviculturally available in these forests. Here therefore is a forest where both silviculture and management demand that the growing stock and yield of I should be increased in future.

9. The method of regulating and controlling the selection yield can now be briefly summarised :—

(1) The felling cycle (usually 15 years) and the selection diameter (usually 20″) are fixed.

The selection diameter is usually fixed high as a matter of policy, to meet the demand for large timber, without examining too carefully the financial results of this policy. In future however it would, I think, be useful at any rate to test the choice of selection diameter with the rate of interest formula and table given in para. 6 above, wherever adequate data are available, if only to see that the exploitation size chosen did not involve actual loss, or some infinite small increase of value.

The felling cycle is arbitrarily fixed, usually to coincide with the working plan period.

(2) The whole working circle or felling series is divided into f annual coupes made as equi-productive as enumerations and the Working Plan Officer's knowledge of the forest permit.

(3) The fraction or percentage that may be felled of selection trees standing in the coupe of the year is calculated on my safeguarding formula.—(*Indian Forester* 1933, page 662).

(4) In determining the value of A in this formula, all factors are taken into consideration, *e.g.*—

(*a*) the actual distribution of the diameter classes compared to what we regard as normal as calculated by my distribution formula (para. 3 above).

(*b*) Silvicultural considerations.

(*c*) The density of the forest as a whole.

(*d*) The need for sustaining average yield and revenue.

After taking all factors into consideration, the percentage is fixed for the period of the working plan, and this is regarded as a maximum. If we were sure of our data, with the sustained yield, safeguarded the interests of the present generation would suggest a definite prescription that this percentage should be worked up to ; on the other hand silviculture, and lack of regeneration or bad spatial distribution may make such purely mathematical yield objectionable.

10. There is one obvious criticism which will be made. What is the use of applying mathematics to yield control when we have not reliable data for t and z on which the mathematics and formulæ are based ? As purely destructive criticism is not much used in dealing with these problems, I would answer this question with another—What is the alternative ? Champion's report shows the danger of a policy of laisser-faire or trusting to luck, and some control appears essential. Should we fix some purely arbitrary limitation, based on the personal and unguided opinion of the Working Plan Officer ? At the present stage of our statistical knowledge, even mathematics lead in the long run to an arbitrary limitation, since t and z have at present to be taken arbitrarily, but they should at least prove of more use in forming an opinion than pure unadulterated guess-work, and as I have indicated above, t and z, which are to some extent interdependent, can be reasonably fixed between certain limits. I would urge that our best policy at present is to collect all the data we can, apply all the mathematics and other aids we can to fix the limitation for the first period, arrange to collect further essential data for our successors and without sacrificing the interests of this generation, try to ensure for the future a sustained or improved growing stock and yield.

11. This article has been written primarily for sal forests, but given the necessary data (particularly for z) it can be applied to any species. Moreover, the method can, if required, be applied to any individual species in a mixed forest. Thus in the miscellaneous forests of the plains and Bhabar, out of scores of timber species, three have to

be exploited separately to supply distinct industries, *i.e.*, *Acacia catechu* for katha and cutch, *Adina cordifolia* for bobbins, and *Bombax malabaricum* for matches. The annual yield of each species can be determined independently of the rest of the forest, and can be prescribed separately either as so many exploitable trees to be felled per annum or as a percentage, calculated on the safeguarding formula. Given the necessary data, therefore, the method is applicable indiscriminately to pure or mixed, regular or irregular, forests managed with selection fellings, where a primary object of management is a sustained yield of trees above the exploitable diameter. It is thus a method which should prove particularly useful in the mixed deciduous or semi-tropical forests of India, as well as in the sal forests managed with selection fellings.

THE ECOLOGY AND CULTURE OF KUTH

(*SAUSSUREA LAPPA*, LARKE.)

BY B. SHER SINGH, M.SC.,

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PART I.—HISTORICAL AND ECOLOGICAL.

I.—INTRODUCTION.

Kuth is admittedly one of the most important and valuable minor forest products, and in Kashmir where it fetches several lacs of rupees as revenue annually, it is certainly the most important. Apart from the revenue it yields, it has an importance all its own, in view of the fact that it occurs now almost exclusively in Kashmir for which reason it is a monopoly of the Kashmir Government. This monopoly has been maintained by the Kashmir Durbar from as far back as the records are available, and although a little smuggling has taken place off and on, in this time, yet this only brings into further relief the monopoly of the Kashmir Durbar, an heritage which the Kashmir Rulers have always prized and guarded with jealous eyes. The ancient

Sanskrit name for this product is *Kushta* or *Kashmirja* (Kashmir-born) which again shows the locality where it was found and from where it was exported.

Kuth belongs to the family Compositæ, and its generic name was given in honour of a celebrated Alpine botanist, namely De Saussure. Of the many Himalayan species, *Saussurea lappa* and *Saussurea sacra* only are important because they are both well-known medicinal drugs. The latter is known locally as *Yogipadshah*, *i.e.* "King of Plants"; it is so much cherished by the *Yogis*, being much in demand for all kinds of nervous debility and other special ailments, also for snake-bite. Whatever its fabulous value to the *Yogis* (Holy men), it has little or no commercial value in that it occurs on high elevations, far away from the haunts of men, and in such little quantity that it is never available otherwise than as a curiosity, a veritable *rara avis*, which perhaps accounts for the local superstition that one person may not collect more than seven plants, the collection of a larger number resulting in one's sudden and self-invited death! Fortunately, there are no such superstitions or natural limitations to the working of its cousin, namely the *kuth* plant which may not be "King of the Plants" in the eyes of Holy men, yet it is certainly so in the eyes of the local foresters, and particularly to the covetous eyes of the smugglers, to whom it offers quick monetary returns, which no other commodity offers in these days of trade depression, be it even diamond hunting in the famous mines of Golconda.

Kuth is used in India and outside for several ailments as rheumatism, scabious itching, curing incurable sores, preparation of valuable scents, but its chief consumption is in China where it is prized as an incense fit only for gods and lamas (who call it "Pachak") thrice sacred to the Tri-buddha deity worshipped in the Far East. "In every 'Hong' it is found; no mandarin will give audience until the *pachak* incense burns before him; in every Joss house it smoulders before the Tri-buddha deity; in every floating junk in the Chinese river—the only home of countless hordes—Buddha's image is found, and the smoke of *pachak* religiously wends its way heaven-wards. This

accounts for consumption of several thousands of maunds annually of *kuth* root in China, the consumption in other countries being at present nominal, although the demand for *kuth* is developing in the west. Its price per maund has varied greatly since the War ; it fetches at present Rs. 150/- per maund.

Formerly all parts of the plant were collected including root, stem and leaves, but since 1918, the collection of the latter two is stopped, for it is the root which is the most important part of the plant and which contains medicinal oil of special value. It is cut up into short lengths of about three inches which are dried and sealed in gunny bags and then exported. A special *kuth* regulation prohibits any person other than the authorised agent from selling, possessing or otherwise dealing in *kuth* in the territories of the Jammu and Kashmir Government.

Although the importance of *kuth* has been well-known, yet it was after some effort that the working of *kuth* was handed over to the Forest Department in the State, the work being originally under the control of the Revenue Department. It was only in 1913 that the Forest Department obtained formal control of the *kuth* areas and their working. This introduced order in place of unregulated working such as prevailed hithertofore, but it was not until Mr. H. L. Wright, I.F.S., took over charge as Chief Conservator of Forests that the actual working of important *kuth* areas was regulated by special plans -*Kuth* Working Plans—which involved thorough investigation of the outdoor conditions by Gazetted Officers who were expected to devote as much time and care to the preparation of *kuth* schemes as to the preparation of deodar and *kail* plans. The importance of this step cannot be over-rated for if *kuth* is to the Kashmir Durbar the proverbial goose which lays golden eggs each year, it is necessary that the goose should be well looked after. These plans did useful pioneer work and will, no doubt, continue to do so. Indeed, the *Kuth* Working Plans must form an integral part of Kashmir Working Plan Control.

The introduction of the *Kuth* Plans in Kashmir served to rivet more scientific attention on *kuth* than was possible hitherto. At the same time, the School of Tropical Medicine, Calcutta, studied *kuth*

from the point of view of its medicinal value, and this has also gone a long way to bring *kuth* into the limelight in the Indian market. But the culture of *kuth* remained somewhat in an experimental stage as even the *kuth* working plan officers had only one season or so to study the plant in the field, while the ascertainment of the best system of culture necessitates prolonged study of the plant under strictly experimental and comparable conditions which facilities have not been available to the above officers. The writer has now been in charge of Ramban Division for about ten years, and in this period about half a dozen plantations have come up successfully in different ranges, and in one plantation, namely Sinthan, Udil Range, there are lacs of established plants, some of them as tall or taller than the writer, and as the writer has also had opportunity of studying *kuth* plant in other parts of the State, hence the following note is drawn up to embody the present state of knowledge about *kuth* in the hope that it may be improved upon in future.

The observations made extend over a decade for which period the above plantations have been carefully watched hence they form a good nucleus for crystallisation of *kuth* experience.

2. *Description of the Plant.*

The following is a complete description of mature plant, as also its important distinguishing characters :—

A tall, robust, perennial herb, with large teak-like leaves when mature, stem 5′-8′ stout, fistular, surrounded at the base by a whorl of large radical leaves, elephantine in size, upper leaves with lobately winged petioles, gradually decreasing in length upwards.

Root.—Stout, long, carrot-like, often up to 2′ long. Sometimes a number of roots coalesced at collar, roots possess the characteristic penetrating odour which can be smelled from a distance whether green or dry, the smell sticking to soil and handling apparatus. Girth anything up to one foot.

Stem.—Stout, fibrous, fistular 10-20 angled, ridges rounded and scabrid, stem hollow below, pithy above, unbranched, leaves at the base as well as above, diameter up to one inch.

Radical Leaves usually in a whorl of 4-12 leaves, and 2′-4′ long including thick petiole which is 1′-3′ long when mature and is then lobed from about 6″ upwards, the size of lobes increasing outwards, alternately placed, often with a membranous continuous base, the ultimate lobe biggest and cordate, as much as 1′-2′ in length and crosswise. The base of the stem and of radical leaves is usually and characteristically red-purple (except when young).

Cauline Leaves similar but smaller, 6″-18″ long including the petiole which bears alternately placed lobes, base auricled, semi-amplexicaul, alternate.

Leaves tomentose when young, afterwards scabrid above but glabrate below, margin of leaves sinuate with papilla on each apex, outline of uppermost lobes ovate-cordate. Uppermost leaves ovate or lanceolate becoming almost sessile near the flowering heads. Veins opposite, pinnate, distant 2″-3″ apart, hairy on both sides.

Flowering Heads, homogamous, disciform, purple-blue or blue-black, very hard and compact when unripe usually terminal in a cluster of 2-7 occasionally 9 heads, also axillary in which case one head of one flower occurs in each axil of the upper leaves. The heads when young covered with characteristic cobwebby tomentum which is like a spider's web ; 1″ to 1·5″ in diameter, sessile.

Receptacle bristly, involucral bracts dark-green within purple outside, sharp-pointed, recurved, ovate-lanceolate acuminate, rigid, many seriate, pubescent when young afterwards glabrous.

Pappus growth 20—40 white hairs, 6″ long, double rowed.

Corolla tube 0·5″—0·8″ long, expanded above, 5 lobed, purple above.

*Stamens,** free, anther-bases sagittate with long hair-like tails, purple, when young ringed round the stigma.

Stigma exserted above anthers, bifid white, style-arms linear, ovary white, inferior 0·2″.

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*In the Compositæ the stamens are joined by their anthers to form a ring. The filaments are free and perhaps the writer means "stamen with free filaments, anther-bases, etc." as written by the writer.

C. E. P.

Fruit. Achenes, glabrous, 4-ribbed, purple, slightly curved, top contracted and cupped 0·3″ to 0·4″ long, with brown pappus hairs 0·7″ long.

Distinguishing characters. The plant is easily distinguished by its *large teak-like leaves with lobately winged, long petioles,* which are thick fleshy, depressed above, and by clusters of hard sessile, blue-black flowers, and by its root which emits characteristic smell. In the forest, its *large leaves* are likely to be confused with the leaves of *Arctium lappa* (burdock) which has the same specific name as *S. lappa*, but the leaves of burdock, though big, are not lobately winged. Leaves of *Caltha* when very big look similar, but they are not hairy, nor lobately winged. When young the leaves are likely to be confused with leaves of Aaron's rod *Ainslea aptera* but the latter are not so hairy as *kuth*.

3. *Distribution and habitat.*

Kuth is found only in Jammu and Kashmir State territories, and although it may have occurred sporadically in non-commercial quantities in tracts adjoining Kashmir, as Chamba and Kagan, yet it has long since been exterminated there by injudicious overworking. For all practical purposes, its true home is Kashmir. Hence, all the *kuth* which finds its way into the market through Chamba or Kagan is really Kashmir *kuth* smuggled by a number of inter-linked agencies which are spread all round the border of the Kashmir State.

In the Kashmir State, it occurs sporadically in practically all the hills at an elevation of about 8,000′ to 12,000′ the quantity increasing towards the higher elevations, but it occurs gregariously at the heads of the Kishenganga and Chenab rivers which drain, respectively, the Kishenganga and Kishtwar valleys which are its chief sources of extraction. In the Kishenganga Valley the *kuth* areas are dotted in the upper hills between 7,500′ to 11,500′, chiefly in Gurez, Tilel, Bagtor and Matsil. In the Kishtwar Valley, the most important *kuth* bearing area is Marwa which is drained by the Renai Nala. This area has been called a mine of *kuth* wealth, but other Ranges, namely, Dachhan, Warwan and Padar have also fair proportion of *kuth*, although in the

last range, the depredations of *kuth* thieves from across the borders have reduced it to a condition of utter exhaustion. In these ranges *kuth* is found on an elevation varying between 8,500′ to 11,500′ and as a general rule it may be stated that the farther away an area from grazing and frequented paths, the better and denser is the growth of *kuth*. In other Divisions also such as Ramban, Langet, etc., there are extensive *kuth* fields, but they are few and far between and far too much interrupted and it would appear that on the whole the climatic factors decidedly favour the Kishenganga and the Kishtwar valleys.

The altitudinal zone of *kuth*, *i.e.*, its true home appears to lie between 9,000′ and 11,000′ above sea-level. Outside this zone it also occurs, but then its growth is either hampered by the associated weeds, or is otherwise stunted. Aspect is next only to altitude in determining its distribution. Generally, northerly aspects are the best, but north-easterly and north-westerly aspects are also favoured, southern slopes being decidedly unfavourable. It is only on very high elevations above 10,000′ that *kuth* grows on all slopes, soils and situations, irrespective of aspect, but even here the sunny slopes are reflected in its stunted growth. *Kuth* likes deep, porous soil whether clayey or sandy, and it is here where the roots are long and thick. In a stiff or rocky soil the root is very stunted indeed. Although *kuth* avoids pebbly soil, yet often it is found in the beds of hilly nalas which are full of stones and pebbles and even here, quite against expectations, the root is sufficiently big which is no doubt due to plenty of sub-soil moisture that is always found in these hilly ravines. On stiff soil it is usually absent. It requires cool surroundings and sufficiently humid atmosphere such as are found on the upper limits of tree growth but it avoids water-logged areas.

Kuth is found chiefly in the high-level fir and birch forests. In the fir forest, it is not found where the density is complete, for it likes open interrupted cover, and this condition is practically always fulfilled by birch. This interrupted canopy appears to give to *kuth* the desired shade from sun, and suitably moist soil. In the fir forest, *kuth* attains best proportions when density of the overhead cover is

0·5 to 0·7, but on higher elevations no shade whatsoever is required, provided the soil and aspect are favourable. The Bakarwal *Gots*, *i.e.*, where they squat on their annual migrations upwards or downwards are also found to stimulate the root growth, for droppings of sheep and goat provide the necessary manure. Other conditions being equal, growth on lower elevations is more rapid than on higher elevations, because here the vegetative season is longer and *kuth* is able to get the required heat necessary for its metabolic processes. Thus, at Sinthan which is only 8,714′, the plant growth is quicker, the dimensions bigger, and the flowering season earlier than even in its natural habitat, for here all other facilities exist, in addition to heat of the lower level, which makes all the difference to its growth. The site, too, being a disused *behak*, is specially favourable.

A special feature of *kuth* is the *gregarious manner* in which it grows, wherever the factors of the soil are suitable. This is no doubt connected with its flowering and regeneration from root-cuttings, features which will be discussed in Part II.

4. *The Ecology of Kuth.*

Having briefly discussed the distribution of *kuth*, we can now go into further details and discuss the climatic conditions which govern the variation. It has been already stated that *kuth* root develops best under the shelter of birch. But we must differentiate between pure birch forests, and birch forests mixed with other broad-leaved species, of which the main species which occurs at the *kuth* elevation is *kharsu* (*Quercus semecarpifolia*). *Kharsu* forests are common in the Jammu Province as in Banihal and Ramban ranges, and it is found that while some *kuth* is found in their vicinity, yet the quantity of *kuth* found is very little. Indeed, comparative study of the higher alpine forests will soon reveal *that the more the kharsu the less the birch, and correspondingly little the kuth.* Thus, the quantity of *kuth* found on higher elevations in the Jammu Himalayas falls rapidly when we go westwards of Kishtwar, where *kharsu* forests begin to predominate. In Mohu-Mangat Valley of Banihal, for instance, it is the *kharsu* which prevails, whereas the birch is almost absent. The proportion of birch increases eastwards of the Pir Panjal Pass, *i.e.*, towards Sinthan until

the maximum is reached in Marwa Warwan where there is little or no *kharsu*, but long stretches of fairly compact birch. It would appear, therefore, that the prevalence and predominance of *kuth* and of birch and inversely of *kharsu* are connected with the distribution of rainfall. The following table brings out the above relation between rainfall and the occurrence of above species :—

Station.	Annual fall of rain and snow.	JAMMU PROVINCE AND HIMALAYAN CONDITIONS.		
		Kuth.	Birch.	*Kharsu.*
Kishtwar Division..	36″	Abundant	Abundant	Nil or very little.
Ramban Range ..	46″	Little	Little	Abundant.
Banihal ,, ..	50″	,,	,,	,,
Bhadrwah ,, ..	49″	,,	,,	Moderate.
Ramnagar ,, ..	71″	Nil	,,	Abundant.

(*N.B.*—Rainfall measurements at headquarter stations only.)

It is clear, therefore, that the same conditions which favour the growth of *kharsu* appear to inhibit the growth of *kuth*. In other words, *the kuth plant is found at its best where the monsoon blast is felt at its minimum.* What it appears to cherish is not so much liquid rainfall in the monsoon months as solid snow in winter, conditions which also favour birch growth. As an indicator of these conditions, we may select *Quercus ilex* (*hiru*), the low-level oak, which grows best where the monsoon fall is least, hence it is that the growth of *Q. ilex* increases as we go into the inner valleys such as Kishtwar or Kishenganga, while the proportion of *kharsu* falls inversely. From the above, it does not follow that *Q. ilex* is *per se* an indicator of *kuth*, for the latter oak grows only on lower elevations, whereas the *kuth* flourishes in and kisses the snow-clad peaks, but the *hiru* oak is a clear indicator of the decreased monsoon conditions which favour the growth of birch and *kuth*, on the corresponding upper elevations of the valleys concerned.

It is understandable as to why the *kharsu* hinders the growth of *kuth*, for the *kharsu* forests are always fairly dense, denser than fir, and the soil is thus not in a fit condition for the growth of *kuth* which is a light-demander. And as *kharsu* is itself gregarious, hence *kuth* cannot grow under its dense cover as it can under the admittedly

open cover of the birch. Although birch and *kharsu* may occur side by side, yet *kuth* always prefers the birch to the *kharsu*, and as an instance it is found that in Mohu-Mangat Pogal-Paristan and Nil forests, patches of *kuth* begin to occur only where birch is able to displace the *kharsu*, *i.e.*, on the uppermost limit of tree growth, and not below 10,000′. In the *kharsu* forests, therefore, such as are found in Ramban Division, natural *kuth* rarely occurs below 10,000′, whereas the occurrence of *kuth* from 8,500′ upwards is a common phenomenon in Gurez and Kishtwar forests where the brown-oak is practically absent.

It must be stated that it is not the rainfall, as such, which hinders the growth of *kuth*, but indirect complications which bring into existence far more powerful competitors of which *kharsu* is but one, albeit an important one. On the other hand, rain is favourable to the growth of *kuth*, hence it is that Gurez forests which receive more rain than Kishtwar (rain at Gurez is 49″ as compared with 36″ in Kishtwar) are richer in *kuth* than even Kishtwar. But given both monsoon rain and heat, *kharsu* will prevail, not *kuth*.

Other conditions being equal, *kuth* prefers low elevations where there is more heat, but when heat brings competitors into existence, *e.g.*, *kharsu* on sunny slopes, then obviously it is the high alpine level which is best suited to its growth, for there competition is comparatively less. The birch forests provide optimum conditions for the growth of *kuth*, as they have very open cover. They also provide the required amount of shade and manure so much needed by *kuth* for its growth. The elephantine-sized leaf of *kuth* (which is covered with hairs densely when young) shows that the *birch-kuth formation* is obviously a climax formation in the high level forests of Gurez and Kishtwar. The very big size of its leaves, its man-high stature, its copious fruiting for which all Compositæ are well equipped, *supplemented by regeneration from dormant buds in the root*, put *kuth* into the very forefront of herbaceous plants growing in these alpine pastures. Certainly the *kuth* plant is the very king of herbs that grow in the Kashmir Himalayas, which has won the palm of victory in the struggle for existence.

A NOTE ON THE HAZARA (N.-W. F. P.) WORKING PLANS.

BY G. R. HENNIKER-GOTLEY, I.F.S.

In the November number of the *Indian Forester* there appears a note on the Hazara Working Plans. I concur with Mr. Wright when he says that Hazara owes much to Greswell for being provided with up-to-date Working Plans. While Mr. Wright has paid full appreciation to the author of the plans, he has been rather severe on those officers who were left to work and manage the plans—more especially the Galis Plan. Mr. Wright says : " Greswell in every case emphasised the need for revision immediately a change of conditions or more silvicultural experience made such a course desirable, and had he remained to carry out his plans, there is little doubt that he would have realized the necessity for revision long before the position became acute."

" As it was, it was not before October, 1931, when the Chief Conservator of Forests toured through the Galis forests that the question of revision came up for consideration.

As regards the Galis Plan which has given the most trouble and about which there has been most criticism.

I was in charge of Hazara from the autumn of 1926 (when I took over from Greswell), until the spring of 1929. Greswell had thus remained to see three years working of the Galis Plan. In the autumn of 1928, I wrote to Greswell at home expressing my doubts and fears of the Galis Plan saying that I considered a rotation of 80 years for blue pine far too short and also that we were failing utterly to get any regeneration. A revision was pressed for then. The following is a copy of a note I wrote on the condition of regeneration in P. B. I. areas in the Galis forests in February, 1929 :—

" Fellings as prescribed in Greswell's Working Plan for the Galis forests were first made in 1923 in the Northern Felling Series and in 1924 in the Southern Felling Series. Efforts to obtain blue pine regeneration either naturally or artificially have met with little or no success in spite of many attempts. In P. B. I. areas the seed whether

it falls naturally or is sown artificially germinates profusely in all cases, but if sown in the autumn all the young seedlings die off in May or June, and if sown during the monsoon die off in October. 1927 was an excellent seed-year and in April 1928 both Periodic Blocks I and II areas were full of young seedlings, but by October practically no seedlings were to be found in P. B. I., whereas in P. B. II many have survived. The conclusion to be drawn from this, is I think, that the initial fellings in P. B. I. are being made too heavily, and the canopy is being opened too much and too suddenly. In addition if all the young poles are ruthlessly removed, the soil is still further denuded of shade and protection, and rapidly dries up. Another cause of failure, is, in my opinion, the attempts which have been made to obtain blue pine regeneration in fir bearing areas, such attempts are a waste of time and money. Such areas are Chattri 3 (*i*) and 4 (*i*). No blue pine regeneration whatever has been obtained, but deodar which has been transplanted over a large part of these two forests is doing well, and is an encouraging feature.

As early as the autumn of 1926 I realised that the wholesale felling of pole woods in P. B. I. was likely to result in the greatest difficulty in obtaining regeneration and I issued a note to paragraph 87 of the Galis Plan as follows :—

" Forests in P. B. I which at the time of felling contain little or no advance growth and no regeneration should be treated with care as regards small groups or even isolated poles under 12″ in diameter. No damage is done by leaving these poles standing at the time of the first fellings, and they can always be removed at the time of the secondary or final fellings, if considered necessary. In the meantime, if left standing, they act as a partial insurance and will (if the worst happens and the original seed-bearers die off before the area is regenerated), act in their turn as seed-bearers ; this will be especially so with the blue pine, which produces seed early in life. By felling them at the first felling they are too small to be utilized, and merely make the operation of cleaning and débris burning more difficult and costly."

" The capital stock of the future is also being wasted, if they were left even for only another 15 –20 years, some revenue could be obtained

from them, whereas now they are quite unsaleable. Since 1926 more poles have been retained, as a result of the above order. According to Form No. 7, 6,005 blue pine poles and 9,573 fir poles of diameters between 6″ and 12″ have been felled in the Northern Felling Series alone, and in addition thousands of poles under 6″ diameter have been removed in clearing the area after fellings have finished. To obtain regeneration in blue pine forests, I consider that the first marking should be done on far more conservative lines than has hitherto been done, and that the majority of poles should be retained until regeneration is definitely established. I would suggest, if convenient, that the Conservator, Utilization and Working Plans Circle, should come to Thandiani in July or August next in order to see for himself the lack of progress made in regenerating Periodic Block I."

In the review by the Chief Conservator of Forests on the report of Forest Administration in the N.-W. F. Province for the year 1928-29, the following is found :—

" In the Galis forests, regeneration has not kept pace with the fellings prescribed, and operations have rightly been restricted in the Thandiani forests. No satisfactory solution of the difficulty of establishing new crops has yet been found. This requires most urgent attention and, if no practicable means of restocking the forests more quickly is found, the 80-year rotation in the Pine Circle must be extended and the prescribed outturn must be reduced."

Again in the report for the year 1929-30, it was written : –" Much money and time continues to be spent on efforts to obtain blue pine and fir regeneration in the Galis forests, but with no success whatever. It is essential that definite action should be taken now and not be postponed any longer. Probably a review of the Working Plan with the extension of the period allowed for regeneration is the only solution. It is quite impossible to grow a I class blue pine or fir tree in a rotation of 80 years, and as events have shown, still less chance of regenerating large areas either naturally or artificially in a period of 20 years."

On the above evidence it seems rather severe for Mr. Wright to state that Greswell would have realized the necessity for revision long

before the position became acute, and to leave the readers of his article with the impression that we, Greswell's successors, did not do so.

Mr. Gotley has kindly let me see this note before sending it for publication. I certainly did not intend to give the impression that the officers following Greswell in Hazara did not realise the need for revising the Galis Working Plan. The point I wished to make was that although every one criticised the plan, nothing was done to alter it until October 1931, when Mr. Trevor drastically reduced the yields, by which time a very large proportion of the area allotted to P. B. I. had been felled over.—H. L. WRIGHT.

BOMBAX MALABARICUM.

By T. P. Ghose,

Chemical Branch, F. R. I., Dehra Dun.

Bombax malabaricum, DC. syn. *B. heptaphyllum*, Cav. Vern. *semul*, Hind ; *Letpan*, Burm. This large deciduous tree, known as the silk-cotton tree, is common throughout India and Burma, except in the most arid tracts (1). It is of economic value since it yields a variety of useful products. According to Watt (2) its timber, though soft and perishable, is used for making rough planks, packing cases, tea-boxes, canoes, toys, etc. From its pods a floss is obtained which is known as silk-cotton, and is chiefly used for stuffing cushions, pillows, mattresses, etc. From its bark is obtained a gum called "mocharus" which is used medicinally. Its root, specially the fleshy tap roots of young plants, which goes by the name of "semul musla" or "musli," is highly thought of as an aphrodisiac and tonic. The flower buds are used as a pot herb.

Since the time of Watt more information has accumulated regarding the properties and possible uses of these products and consequently the economic value of this tree has increased. In some quarters even exaggerated estimates are being put forward regarding its commercial possibilities. It has, therefore, been thought desirable to bring together all the available information regarding these products, so that

a more correct estimate about their economic value may be formed. The glowing terms in which the medicinal properties of the root, the "semul musla" is described in indigenous system of medicine also appeared to be exaggerated. The results of chemical investigation of the roots are, therefore, embodied in this note for general information.

Wood :—The *semul* wood (1), (3) is soft, light and creamy white in appearance. It can easily be sawn and seasoned. If air-dried, it soon gets discoloured but if it is kiln-seasoned immediately after conversion, it retains its fresh white colour for a long time. Being a soft wood it is easily attacked by fungus, white ants and borers, but it is extremely durable under water. It is mainly used for making rough planks, packing cases, tea-boxes, etc., and in the present-day much of the annual output is consumed for such purposes. But with the development of match industry in India, one more important use has been found for it, namely the manufacture of match boxes for which it has been found suitable. Thus during the recent years there has been a considerable demand for this wood in the match industry (1). In the United Provinces the Forest Department sold 114,404 cubic feet of logs and 35,851 cubic feet as sawn wood, in the year 1929-30 (5). Bulk of the logs was purchased by the match and other factories located in the province and a portion went to Bihar and the Punjab. From a preliminary enumeration it has been estimated that from certain Forest Divisions of this province, as much as 640,000 cubic feet of *semul* and *gulel* wood (*Trewia nudiflora*—another wood suitable for match industry) can be obtained. As such, the United Provinces not only meets the local demand for this wood but also supplies the same to adjoining provinces and is capable of meeting further increase in consumption. It is likely that, with the expansion of the match industry, its demand will increase still further. In centres like Bombay where according to the Tariff Board Report (4) " the question of the supply of Indian wood at a reasonable price is acute," this wood will find a ready market if a regular supply at a reasonable rate could be assured. For purposes of permanent supplies of this timber at a comparatively cheap rate, plantations would be necessary near centres of demand. Such plantations, if they are cautiously started in suitable

localities and are worked on sound silvicultural basis, are likely to prove financially successful, specially as *semul* is a fast growing tree. Troup (1) considers that " the economic value of the *semul* as a timber tree lies mainly in its rapid growth and volume-production, for although the actual value of the wood per cubic foot may be small, this tree may, under favourable conditions, yield returns higher than those yielded by trees with more valuable timbers."

Indian kapok:—The floss of *semul* is light, elastic, buoyant, impermeable to moisture and has a smooth shining surface. It has not, hitherto, been used as a textile, because its smooth surface and absence of axial twist prevent it from being carded or spun. It is exported under the name of Indian *kapok*, to distinguish it from Java *kapok*, the floss of *Eriodendron anfractuosum*, which is long stapled and is considered superior to *semul* floss by virtue of its greater resiliency.

Both Indian and Java *kapoks* are used in the upholstery industry. But for some years Java *kapok* has found an extensive application in the manufacture of lifebuoys, life-belts and other life-saving appliances at sea. *Kapok*, on account of its great buoyancy, freedom from water-logging and its greater weight-bearing capacity, surpasses cork and reindeer hair which are its chief competitors for making these life-saving appliances. It loses only 10 per cent. of its buoyancy after being in water for 30 days, and after drying fully regains its original supporting power (16). The Board of Trade regulations therefore stipulated that only Java *kapok* may be employed for such purposes. In 1919 the Imperial Institute made a thorough investigation regarding the suitability of Indian *kapok* for the manufacture of life-belts and such other life-saving appliances (7), and the results of this investigation show that Indian *kapok*, in a reasonably clean condition, fully satisfies all the requirements of the Board of Trade as regards buoyancy and freedom from water-logging. *Semul* floss is sometimes mixed with a *akund* floss (*Calotropis procera*), which, although similar to it and meets some of the requirements of the Board of Trade, cannot stand rough usage and quickly gets water-logged. The following table taken from the Bulletin of the Imperial Institute (7) gives the results of tests made on machine-cleaned *semul* and *akund* floss as compared

to Java *kapok*. It also shows how far these flosses conform to the specifications of the Board of Trade which enjoins that "life jacket must have 24 ozs. of *kapok* which gives it its buoyancy and a jacket intended for use by adults must be capable of supporting 20lbs. of iron in fresh water for 24 hours with 15lbs. of iron attached."

Description.	WEIGHT REQUIRED TO SINK A BAG CONTAINING 4 OZS. OF THE FLOSS IN FRESH WATER. A Immediately after immersion.	B After 24 hours in water with 40 ozs. iron attached.	C Weight of water absorbed after expt. B.	D After rough treatment and 44 hours further immersion with 40 ozs. of iron attached.	Calculated weight supported by 24 ozs. of floss after 24 hours immersion with 15 lbs. of iron attached.
Commercial Java *kapok* No. 1 ..	83 ozs.	87 ozs.	3 ozs.	68 ozs.	32·6 lbs.
Do. 2 ..	82 ,,	91 ,,		63 ,,	34·1 ,,
Indian *kapok* machine-cleaned No. 1 ..	99 ,,	97 ,,	3 ,,	70 ,,	36·4 ,,
Do. 2 ..	107 ,,	107 ,,		58 ,,	40·1 ,,
Akund floss machine-cleaned No. 1 ..	80 ,,	69 ,,	14 ,,	sank with less than 40 ozs. of iron attached.	25·9 ,,
Do. 2 ..	74 ,,	45 ,,			16·9 ,,

From the above it will be seen that Indian *kapok* is superior to Java *kapok* in buoyancy and is almost its equal in withstanding rough treatment and thus fully satisfies the Board of Trade specifications. The samples examined by the Imperial Institute, however, were found to contain more adventitious matter, such as fine sand, leaf and pieces of pods, than commercial grades of Java *kapok*. But the Board of Trade still disapproved of the use of Indian *kapok* in the manufacture of life-belts, etc., on grounds that "(*a*) it is liable to be adulterated with *akund* floss, (*b*) that no commercial standard for Indian *kapok* has been established, (*c*) that no guarantee is obtainable that the commercial supplies would be equal in quality to that tested by the Imperial Institute. Later on, at the instance of the Imperial Institute (9) the Board of Trade agreed to carry out official tests on *semul* floss.

These trials gave satisfactory results and the Board subsequently allowed Indian *kapok* to be used for this purpose, subject to the condition that a definite and reliable standard should be established and maintained. It is difficult to estimate how far the permission given by the Board in 1921-22 for the use of Indian *kapok* in the manufacture of life-belts and other life-saving appliances has helped the trade in this product. The following table, however, shows the volume of export trade in this product in years prior to and subsequent to the grant of such permission (17):—

Country of export.	1914-15.			1923-24.			1932-33.		
	Quantity in cwt.	Value.	Value per cwt.	Quantity in cwt.	Value.	Value per cwt.	Quantity in cwt.	Value.	Value per cwt.
		Rs.	Rs.		Rs.	Rs.		Rs.	Rs.
British Empire	6,917	2,07,796	30·0	12,415	7,37,052	59·4	6,491	1,94,849	30·0
Other foreign countries ..	9,106	2,25,234	24·7	21,421	13,02,925	60·8	16,822	4,42,783	26·3
Total for all countries ..	16,023	4,33,030	..	33,836	20,39,977	..	23,313	6,37,632	..
Value realised per cwt. of raw cotton exported from India to British Empire	..	..	27·0	..	..	82·4	..	..	26·9

During the period of post-war boom in trade, there was a considerable improvement in the quantity of *kapok* exported and the value realised. But even during this period the volume of Indian trade in this product represented only a fraction of the trade in Java *kapok*. In 1924 Java and Madura exported as much as three hundred thousand cwt. of *kapok* of a total value of about 1½ million pounds sterling (10). Although following the general trade depression, the prices have reached pre-war level, Indian *kapok* is still selling almost at the same rate as raw Indian cotton and the total export has not contracted to what it was in 1914-15. It may, therefore, be reasonably expected that with general improvement in trade, its demand will also increase. But unfortunately Indian *kapok* is still considered as inferior to Java

kapok. Vanstone writing in 1929 (6) remarked "The principal supply of pure *kapok* comes from Java, with smaller quantities from the Philippines. The floss exported from India under the name *kapok* is chiefly the product of *Bombax malabaricum*, the red silk-cotton tree, and is inferior in quality." In 1926 double-cleaned Calcutta *kapok* was quoted at 1s. to 1s. ½d. per lb. or 3d. less than the prime Java (11). Hence to improve the trade in this important product greatest care has to be exercised in supplying properly prepared material equal to or approaching the Java product in quality, and to do that nothing is more important than careful collection of the floss. By ensuring a regular supply of uniform quality, free from adulteration, it should be possible to considerably augment its trade.

Oil from kapok seeds :—The seeds of *Bombax malabaricum* yield an oil which finds a limited use in India as a burning oil. Prior to the examination of this oil in the Imperial Institute (8) nothing definite was known about the composition of the Indian *kapok* seed oil, since no distinction was made in the past between oils from the Indian and the Java *kapok*. The results of this investigation may be summarised as follows.

The Indian *kapok* seeds analysed contained 8·9 per cent. of moisture and yielded 22·3 per cent. of oil on being extracted with petroleum ether, which works to 24·5 per cent. oil on dry seeds.

Constants.	Indian *kapok* seed oil.	Java *kapok* seed oil.
Sp. Gr. at 15°/15° C ..	0·9208	0·921-0·923
Acid value ..	9·3	variable
Saponification value ..	193·3	190 to 197
Iodine value ..	78·0	95 to 110
Volatile acids, soluble ..	Nil	..
Do. insoluble ..	0·5	..
Unsaponifiable matter per cent.	1·0	..
Refractive index at 40° C. ..	1·461	..
Solidifying point of fatty acids	38·0° C.	..

The two varieties of oil are generally similar in properties excepting that the Indian variety has a much lower iodine value. The seeds were submitted by the Imperial Institute to a firm of oil-crushers for commercial evaluation and they reported that the yield of oil was higher than that usually obtainable from Java *kapok* seeds. It also appeared to be of better quality and more suitable for refining for edible purpose. Further enquiries instituted by the Imperial Institute brought out the information that "the Indian seed, if produced in commercial quantities should find a ready market in this country at prices equal to or slightly above those realised by the ordinary commerical *kapok* seeds" (10). At present, the higher grades of Java *kapok* oil is used in margarine manufacture and the lower grades in soap-making (6). The residual meal left after extraction of the oil was also examined by the Imperial Institute and was shown to be richer in proteins than commercial *kapok*-seed cake. It was also found to possess higher nutritive value than undecorticated cotton-seed cake (8).

	Composition of Indian *kapok*-seed cake containing 7 per cent. of fat.	Undecorticated cotton-seed cake.	Commercial *kapok*-seed cake.
Moisture ..	10·7	13·75	13·8
Crude proteins ..	34·2	24·62	26·25
Fat ..	7·0	6·56	7·47
Carbohydrate, etc. (By diff.)	23·1	29·29	23·19
Fibre ..	18·7	21·19	23·19
Ash ..	6·3	4·60	6·10
Nutrient ratio* ..	1 : 1·2	1 : 1·67	1 : 1·5
Food units† ..	126	107	107

* Nutrient ratio :—is the ratio between percentage of crude proteins and the sum of the percentages of starch and fat, the latter being first converted into its starch equivalent.

† Food unit :—is the total obtained by adding the percentage of starch to 2·5 times the sum of the percentages of fat and crude proteins.

It thus appears that the Indian *kapok*-seed cake would make even a better feeding stuff for cattle than similar type of oil-seed cake already in the market. Both the oil and the oil-seed cake having thus been shown to be of superior quality and readily saleable, all that is needed is propaganda to push their trade and to assure a regular supply of uniform quality.

Mocharus :—Bombax malabaricum yields a gum which is of a reddish brown colour, hard and brittle. The larger tears being hollow in the centre and have the appearance of a gall. It is commonly sold in the bazaar as a medicine under the name of " *mocharus* " (2). According to Pharmacographia Indica (12) *mocharus* is not a normal juice but the product of a diseased action which consists of the proliferation of the parenchyma cells of the bark; upon making a section of the diseased parts a number of small cavities are seen, which contain a semi-transparent jelly-like substance consisting of oblong cells containing a little granular matter, and a small group of starch cells. When first exuded it is whitish but gradually turns red and finally dries into a brittle mass. Phillips (13) has examined this in detail and has found it to contain a considerable quantity of tannins of the catechol and mixed types. On acid hydrolysis it yields " semul red. " It is only moderately soluble in alcohol. The filtrate from hydrolysis was found to contain reducing sugars. The chemical analysis does not indicate anything beyond its astringent properties. But all the same it is a common bazaar medicine. According to Kirtikar and Basu (14) the gum is an astringent and has also tonic and alterative properties and is used in diarrhœa, dysentery, and menorrhagia.

Semul musli :—The roots of *Bombax malabaricum*, commonly known as " musli " or " semul musla," is highly reputed in the Indian system of medicine as a tonic and aphrodisiac. According to Kirtikar and Basu (14) " there is no doubt that it is one of the useful drugs in this country, but the exaggeration of its good effect in some of the Indian writers is so great that it is quite ridiculous and not worth mentioning. It is a good demulcent tonic, and slightly aphrodisiac, but nothing beyond."

A detailed chemical examination of this root was carried out with a view to determine the active principle, which might be responsible for the above-mentioned properties. Although ordinarily the roots from the big trees are collected, but for medicinal purpose the tuberous tap roots of young plants are preferred. Hence, for the purpose of chemical examination, tap roots of plants, two seasons old, were collected. In appearance these were orange grey, tuberous sticks, $1\frac{1}{2}$—2 inches thick and about $1\frac{1}{2}$- 2 feet long. The fibrous skin was peeled off and the white pulpy portion, having the softness and taste of turnips, was cut in small bits, dried at 95°C, finely powdered and analysed. This powder, when soaked in fifty times its weight of water swelled up into a jelly, showing the highly mucilaginous character of the root. On analysis it was found to contain the following constituents :—

Moisture	..	7·5 %
Ash	..	2·1 ,,
Proteids	..	1·2 ,,
Fatty matter	..	0·9 ,,
Phosphatides (cephalin)	..	0·3 ,,
" Semul red "	..	0·5 ,,
Tannins	..	0·4 ,,
Nontans	..	0·1 ,,
Sugars (Arabinose and galactose)	..	8·2 ,,
Starch	..	71·2 ,,
Pectus matter	..	6·0 ,,
Cellulose	..	2·0 ,,

Several samples of roots of various ages were examined and it was noticed that the proportion of the constituents differed with the age. The younger ones had greater proportion of sugars, starch and pectus matter and less of oil, colouring matter and cellulose, while the maturer ones were richer in oil, tannin and cellulose.

The phosphatide cephalin is associated with the fatty matter. The mucilage appears to be a silico-phosphoric ester of manno-galactan.

Of all the constituents the only substance which could impart to the root its medicinal properties, appears to be the phosphatide cephalin. It may be that the mucilage is to some extent responsible for its medicinal properties, since Daoud (15) ascribes the medicinal properties of fennugreek (*Trigonella foenum*, L.) to a similar mucilage. It is also of interest to note that "safed musli," the common name for the tuberous roots of *Asparagus adscendens*, Roxb. and of *Chlorophytum aurendinaceum* (14) to which similar medicinal properties are ascribed, is also highly mucilaginous. This also lends support to the view that mucilage consisting of silico-phosphoric ester of polysacharides, acts as a demulcent tonic. "Semul musli" is not so common in the bazaar as "safed musli" perhaps because the young plants are not generally dug up for the tap-root. This however will be possible from a plantation and since the chemical analysis show that it contains substances which act as a tonic, it will be worth while to introduce more of "semul musli" in Indian markets and thus place within the reach of the poor a good and harmless tonic.

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STUDIES IN THE CONTROL OF SPIKE DISEASE IN SANDAL,

PART II.

USE OF PLANT POISONS IN CONTROLLING THE SPREAD OF INFECTION.

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It was shown in the previous communication (1) that the spiked sandal is the centre of infection from which the disease is transmitted to healthy plants in the neighbourhood. Evidence was also adduced to show that the most effective way of controlling the spread of infection lay in the elimination of the diseased plant itself. It was further indicated that the removal of these sources of infection by mechanical means is not only slow and difficult, but also highly costly, so that it would be necessary to adopt other quicker and more efficient methods of destroying spiked trees in affected areas. The present communication relates to the use of plant poisons for this purpose.

In recent years, application of different chemicals, chiefly arsenites and chlorates, as agents for the destruction of undesirable plants and plant pests, particularly weeds, has received some attention. Cope and Spaeth (2) have discussed the advantages resulting from the use of tree-killers for the permanent removal of undesirable growths. According to these authors, tree-killers would serve in silvicultural practice to (1) prevent the sprouting of inferior species, (2) check the sprouting of all species where it is desirable to have better growth of seedlings, (3) remove inferior hardwood species, and (4) eliminate the understory of other undesirable varieties. MacKinney and Korstian (3) found that the use of sodium arsenite as plant poisons was not only effective in removing undesirable trees in forest stands,

but also that it was cheaper than felling or girdling alone. Although poisonous chemicals find application in the form of sprays and spray solutions in combating insect attacks, yet their use in controlling the rapid spread of disease in economic plants has not so far received adequate attention. One of the objects of the present communication is therefore to investigate the possibility of employing chemicals for controlling the spread of infection, with particular reference to the spike-disease of sandal.

In view of the need to have a standard for comparing the relative efficiencies of different tree-killers, some preliminary trials were carried out as the result of which a period of four weeks was chosen as the maximum time for the poison, if potent, to be effective in killing out the treated plants. The results of the various treatments were compared with those for the "Atlas" tree-killer, though even this preparation was not quite consistent in its action, being conditioned by several unknown factors.

Materials and Methods.—With a view to securing effective translocation of the poison, the following methods were adopted—(1) girdling the tree just above ground level to a width of half the girth of the plant, removing the entire bark and smearing the poison on the exposed woody portion ; (2) partial removal of the bark to expose the red cortex region and subsequent application of the solution on the exposed part ; (3) discontinuous, horizontal incision of the bark made with a knife in place of girdling, so as to maintain continuity in translocation, followed by smearing the poison ; and (4) boring four holes, each half inch in diameter and two or three inches deep in the trunk and applying the poison with a brush or injecting it with a gun specially devised for the purpose.

The above treatments were confined to diseased plants only. A few healthy trees were also treated with a view to obtaining a comparative idea of the action of the different chemicals in such cases.

Iron and Copper Salts.—It is well-known that the salts of iron and copper are highly toxic to plants. Some experiments were carried out therefore applying the sulphates of the two metals either as

concentrated solutions or as powder. In addition to this, copper was made alkaline and the solution mixed with phenol to help the poison to penetrate the tissues. The results are given below :—

TABLE I.

Effect of iron and copper salts in killing spiked sandal.

Time of treatment.	Mode of application.	NUMBER OF PLANTS DEAD.			
		Ferrous sulphate.		*Copper sulphate.*	
		After 3 weeks.	After 8 weeks.	After 3 weeks.	After 8 weeks.
October 1931 ..	Girdling fully ..	0/12	2/12	foliage shed	1/6
	,, partially ..	0/6	1/6	,,	1/6
	Bunging into holes ..	0/6	1/6	,,	1/6
February 1932 ..	Girdling fully ..	0/27	0/27	0/6	0/6
	,, partially ..	0/6	2/6		
	Bunging into holes ..	0/6	2/6	0/6 (Phenol and $CuSO_4$ 1 : 1)	0/6
February 1933 ..	,, ..	(Ferrous chloride) 0/6	1/6		
	Girdling fully ..			Partial shedding of foliage.	1/10
	,, partially ..			1/10	2/10

It may be seen from the above that copper and iron salts are not quite effective in killing spiked sandal plants.

Phenol.—In February 1932, 6 trees were treated with crystalline phenol by boring and filling. Eight others were girdled and smeared with a saturated solution of the same. Except for the withering of leaves in two of the plants no other visible effect was observed.

Aluminium sulphate.—Six plants were girdled and smeared with a saturated solution of this salt. Of these two died within a month after treatment.

A large number of trees were smeared after girdling with crude tar, p-dichlorobenzene, magnesium chloride, ethylene chlorohydrin,

ammonium salts, sodium silicofluoride, and sodium chloride without any satisfactory result, irrespective of the method of application.

Chlorates.—The use of chlorates for the destruction of weeds is a recent practice. No attempt has so far been made, however, to employ them for killing trees. In the present study sodium and potassium chlorates were used as concentrated solutions either individually or combined with calcium chloride. The trials were conducted in Noganur and Aiyur R. F., North Salem.

TABLE II.

Effect of chlorates on spiked sandal.

Time of treatment.	Chemical used.	Method of application.	NUMBER OF PLANTS THAT DIED	
			after 3 weeks.	after 2 months.
July 1932 ..	Potassium chlorate.	Boring holes and filling up.	2/6	6/6
February 1933 ..	Sodium chlorate.	Girdling and smearing.	Leaf withering in 6	2/10
	,,	Incising and treating.	1/10	6/10
	,, with calcium chloride added.	,,	Leaf withering in 2	1/6
		Girdling and smearing.	2/6	3/6

It may be seen from the above that although chlorates are more effective in killing spiked sandal trees than iron or copper salts, they are yet not very rapid in their action.

Arsenicals.—The patented arsenical preparation, "Atlas" tree-killer was first tried in North Salem to determine whether spiked sandal could be cured by its application. In one partially diseased tree, the attacked part was girdled and smeared with that preparation. The portion above the treated part died after a month, while the rest of the tree continued healthy for a period of three years, indicating thereby that the spread of infection was checked for a time as the

result of the treatment. After that period, however, the same tree got spiked through apparently fresh infection, so that although the application proved ineffective as a means of curing the malady, it suggested the possibility of destroying the diseased part by treatment with arsenicals and thereby arresting the spread of infection in an affected locality. The results with "Atlas" for various seasons are given below :—

TABLE III.

Effect of applying "Atlas" solution to spiked sandal.

Season of treatment.	Number of plants treated.	Method of application.	Observations after 3 weeks.	Observations after 4 months.
		Atlas tree-killer solution.		
January 1931 ..	60	Girdling and smearing.	25 died	54 died
October 1931 ..	6	Do.	Leaf withering	5 ,,
	6	Partial girdling	Do.	1 ,,
February 1932 ..	98	Girdling	30 died	98 ,,
	6	Partial girdling	Leaf withering	4 ,,
	6	Coppicing and smearing.	All died	..
	6	Boring holes and filling.	Do.	..
July 1932 ..	50	Girdling and smearing	27 died	27 died
February 1933 ..	10	Do.	6 ,,	7 ,,
	10	Incising and treating.	partial leaf withering	4 ,,
		"Atlas" and water (1 : 1)		
February 1932 ..	54	Girdled and smeared.	12 died	54 died
	6	Pouring into holes	2 ,,	6 ,,

Although "Atlas" solution is more effective than the other poisons so far tried, its action on spiked sandal is still not very rapid. The diluted solution is less potent than the concentrated one. The efficiency of the preparation is influenced by season, the effect being less pronounced during the monsoon than at other periods. This observation is in agreement with those of previous workers. The trees in the more advanced stages of the disease are less rapidly killed than those in the earlier stages owing to accumulation of starch and consequent defective translocation of the poison in the former as compared with the latter.

In addition to the above, sodium and potassium arsenites and other solutions containing arsenic together with excess of alkali or acid were tried. The results are presented below.

TABLE IV.

Effect of arsenites and arsenates on spiked sandal.

Chemical employed.	Method of application.	Number treated.	SEASON OF TREATMENT WITH OBSERVATION AFTER	
			3 weeks.	4 months.
				July 1932.
Sodium arsenite $2\frac{1}{2}$ lbs. per gallon.	Girdling and smearing.	50	..	.. 35 died
				December 1932.
Potassium arsenite $2\frac{1}{2}$ lbs. per gallon.	Do. ..	15	7 died	.. All died
Sodium arsenate-saturated solution.	Do. ..	9	Leaf withering ..	,,
				February 1933.
Do.	Incising and treating.	10	Leaf withering ..	3 died
				May 1933.
Do.	Girdling and smearing.	44	Leaf withering in 12	18 died

TABLE V.

Efficiency of other arsenical preparations in killing spiked trees.

Composition of solution.	Time of application.	Method of treatment.	Number treated.	No. of plants that died after	
				3 weeks.	4 months.
2 lbs. As_2O_3 and 1 lb. NaOH in 1 gallon.	February 1932	Girdling and smearing.	11	Top withered in 8	11 died
		Partial girdling and smearing.	6	2 died	3 ,,
		Coppicing and smearing the exposed part.	6	6 ,,	..
		Boring holes and injecting.	6	2 ,,	6 ,,
	July 1932 ..	Girdling and smearing.	50	15 ,,	30 ,,
4 lbs. As_2O_3 and 1 lb. NaOH per gallon. ..	February 1933	Do.	5	Top dead	5 ,,
		Bark incision and smearing.	5	,,	5 ,,
Arsenic chloride in dil. hydrochloric acid.	Do. ..	Do.	10	9 ,,	10 ,,
	Do. ..	Girdling and smearing.	10	Leaf withering in all.	10 ,,
Arsenic acid saturated sol. ..	May 1933 ..	Do.	39	,,	23 ,,
	February 1933	Do.	6	,,	6 ,,
Do. ..	Do.	Incision and smearing.	6	,,	6 ,,
5 lbs. As_2O_3 and 1 lb. NaOH per gallon. ..	Do.	Do.	10	,,	9 ,,
	Do.	Girdling and smearing.	10	,,	6 ,,
	May 1933 ..	Do.	31	28 died	31 ,,

Among the pure salts that were tried, potassium arsenite was the most effective, the corresponding sodium salt being relatively less

efficient in killing spiked plants. Of the other preparations both arsenic chloride and the one containing a high concentration of arsenic in alkali solution seem to be the most efficient. The latter has since been used to kill a large number of plants, of the order of thousands, for controlling the spread of disease in North Salem and Coorg forests. The concentrated solution has an additional advantage in that a single treatment is sufficient. Its potency is not appreciably affected even if there is a shower of rain following immediately after its application.

DISCUSSION.

As a means of removing undesirable tree species, the method of girdling has been extensively studied and recommended by Brewster and Larsen.(4) The present authors observed, that on mere girdling, epicormic shoots develop below the "ring." In the diseased plants such growths show symptoms of disease and being proliferous in growth give rise to heavy infection, which is dangerous from the point of view of disease control. It was necessary therefore that by some means the production of such shoots and even root-suckers must be prevented. Generally one has recourse to poisonous chemicals. Among the several plant poisons studied in this investigation, arsenicals were the most effective and helped to destroy the majority of diseased trees in under four weeks. Iron and copper salts were comparatively less satisfactory and the slightly better action of alkaline copper would indicate that the effective penetration of the metallic poison is an important factor in determining its efficiency as a tree-killer. Addition of sulphuric acid to an iron salt does not, however, help the translocation of the poison. Alkali, on the other hand, precipitates iron so that some other method of applying iron salts should be devised. Experiments in this direction are in progress and will form the subject of a later communication. The chlorates are also weak in their action in spite of their solubility and rapid penetration. It is not improbable however that a large part of the chlorate was reduced through oxidation of plant tissues, so that the quantities that were transferred to the different parts of the tree diminished considerably in consequence.

Though arsenicals are the most potent, it should, nevertheless, be admitted that their action is not often instantaneous. In view of the need to eliminate the diseased plants as rapidly as possible, extensive work is necessary to standardise not only the composition of the preparation to enhance its activity but also the time and manner of application so as to secure the most satisfactory results. Further work in this direction is under way. It may be of interest, however, to record that in all cases where arsenic has proved effective in killing diseased plants, the immediate symptom is evident in the colour of the leaf changing from pale yellow or green to a characteristic brown. The leaves thus affected are also flaccid in the early stages. Such specimens though apparently alive and green, are still non-infective, since artificial transmission experiments with them have led to negative results. Patch grafts with the bark of these twigs have not transmitted the disease to healthy operated plants.

SUMMARY.

(1) Copper and iron salts are not effective in killing out spiked sandal which acts as a source of infection to healthy plants in a diseased locality. Chlorates are slightly more potent, but they are not rapid in their action.

(2) " Atlas " tree-killer was found to be useful in killing out the majority of affected trees in under four weeks but its action is influenced by the season and the stage of the disease. Arsenicals are found to be the best for the purpose, though further experiments are necessary to test the relative potencies of these poisons.

(3) Among the several methods of applying tree-killers, girdling the plant followed by smearing the poison was found to be the most useful.

In fine, the authors desire to express their thanks to Professor V. Subrahmanyan, D.Sc., F.I.C., and to Mr. A. M. C. Littlewood, I.F.S., for their keen interest in the course of this work.

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THE EFFECT OF DEFOLIATION ON THE INCREMENT OF TEAK SAPLINGS.

By H. G. Champion, Silviculturist, F. R. I., Dehra Dun.

Forest Bulletin No. 89 *of* 1934.

This very important study has provided statistical evidence of the huge amount of loss brought about by the skeletonising and defoliating Lepidopterous larvæ which gives an indication of the expenditure that may be reasonably incurred on control measures.

The most serious aspect of the loss, *viz.*, the depreciation due to consequent forking of the bole could not be assessed from the obtainable data but it has been shown that the value of the loss due to reduced increment alone amounts to Rs. 100 per acre for severe defoliations and Rs. 50 per acre for moderate defoliations. The expenditure of Rs. 50 per acre in order to prevent prolonged severe defoliation which would occur without it and of Rs. 20 per acre to prevent a single complete defoliation early in the season seems quite justifiable.

The relation obtained between the volume increment laid down during a season and the active leaf surface (total leaf surface x the functional period) is very interesting and shows that it takes a million square feet of leaf surface 9·6 days to build one cubic foot of wood.

M. A. K.

EXTRACTS.

WHY BIRDS SING ?

BY KERRY WOOD.

Consider the reason for a bird's song. Young folks learn from nursery rhymes and from fairy-tale telling parents that birds sing to please us. Later on, that may be modified a little, and the children then learn that birds sing because they are happy. And this is the belief that we so often carry over from childhood days to older years.

However, there is more to a bird song than that.

First, you may understand that in the majority of our migratory birds, the males come back to the breeding grounds several days in advance of the females in the spring time,—this was a puzzle to naturalists for years, until the reason for a bird's song was better understood. The moment the males reached our northern country, they did not start to sing. But a few days later they suddenly burst into song, and that song was continuous from then on. If you looked closely, you would fai to find any females near as yet.

The song of the male can be likened to the fence that surrounds our human holdings. The song is primarily to establish territorial rights. All those of that bird's kith within hearing know that the little area immediately around the singer's favourite rches is reserved. It is his Territory.

Of course other males may object to some of these claims, and some bitter fights will result as the disputers argue about the right to hold certain territories. And then the victor sings again and the rest of his bird world knows that " this is my claim, and trespassers will be prosecuted."

Apart from feeding, the singing is the most important part of his day's routine at this time.

A week or ten days pass, and then the females arrive. Contrary to those cherished thoughts of mankind, the male bird does not get off in pursuit of the female and win her. The shoe is on the other foot. The female comes and claims the male, along with his established territory !

The male bird in many of our smaller species, robins, for instance, has also located the nest site before the female arrives and often has half the nest constructed by the time she reaches the breeding areas. This fact upsets another fanciful little theory that the female is responsible for the choosing of the next site and the most of the building work.

With the advent of the female's arrival the male must sing more frequently than ever, for there is soon to be something worthy of his territory-holding song. Mating has taken place shortly after the female's coming, and so by the time the two birds finish the nest and she has put in the daintier touches of lining and the like, she is ready to lay her first egg.

Throughout the egg-incubation time the male sings strongly. It is argued, and with sense, that besides the purpose of his song as a territory-warning, at this time

it also serves as a way of assuring the nesting female that all is well and that no danger threatens.

Then the young birds are hatched, and the male bird leaves his singing perch for short periods to assist the mother bird in gathering food for the young. Still he sings for it is still very important that the territory-claim be kept to the fore.

But as the young grow, they require more food, and that takes more time away from the singing perch. And as the young approach the time of leaving the nest, the two adult birds are kept busy every minute of daylight gathering food for the hungry mouths. You will see that the song of the male is not so important, now that the young are reaching the time of leaving the nest and the claimed territory, and so the song period grows less and less, every day the male bird having fewer moments to devote to that duty.

Now comes the time of the young's first flight. The nest is deserted and the family goes on its travels. There is now little need for the male's song, except possibly for a short time in the evening when he must establish a claim to that particular territory where his birds are roosting for the night.

Gradually then our robin's song stops, until the young have grown up to the independent stage and left the old birds. If the season is not too far advanced, you will hear the males start their singing again,—only a few days of it this time, and some female who is free from first-family cares will come and the little cycle starts all over again. In a particularly beneficial season, some authorities claim that the robins may raise three broods of young. It will then be autumn and while you will see large flocks of these birds gathering for the migration flight, you will never hear the males give the glad songs of spring time and summer. The need has ended.

(*Forest and Outdoors*, May 1934).

THE ROLE OF VEGETATION IN EROSION CONTROL AND WATER CONSERVATION.

BY W. C. LOWDERMILK,

Vice-Director, Soil Erosion Service, Department of Interior.

[Much is being said and written nowadays about erosion and flood control and watershed protection, in short, forest influences. It is well that the information forming the basis of programmes of land management under consideration be thoroughly established. It is the only way for permanent advancement. While a voluminous literature on the subject of forests, floods and erosion exists much of it is controversial indicating incompleteness of scientifically established knowledge in this field. This paper by Dr. Lowdermilk who has been carrying on experimentation for a decade, briefly reviews the status of our information on certain phases of the rôle of forest and other vegetation in erosion flood control and water supply, and indicates at what points investigations have been made and need to be made to bring the knowledge in this field up-to-date.]

Importance of indirect products of forest vegetation in national economy is increasing. Crowding of populations to which Taylor (43) calls attention, higher standards of living, general industrialization, increase of grazing herds and extension of irrigation even into humid regions of capricious seasons, require consideration of forest and other natural vegetation as it affects recreation, hydraulic power, water supply, flood control, soil erosion, and useful life conservancy works. (36) As urban centres have grown and irrigation has been extended into semi-arid regions, water as a product of mountainous watersheds has reached in many sections values greater than those of timber, forage crops, or other uses. (12) Management of forested areas for the production and control of water has become of great importance in regions of multiple land use, and of first importance in semi-arid regions.

STATUS OF KNOWLEDGE OF ROLE OF FOREST VEGETATION.

Our knowledge of the inter-relations of forest vegetation, climate, and streamflow is unsatisfactory. Contrary conclusions have been reached by serious students of: (1) Forests and rainfall; (2) Forests and climate; (3) Forests, streamflow and erosion; (4) Forests and water supply.

(1) Brookes (5) in his re-examination of the literature on forests and rainfall concludes that forests may increase rainfall 1 to 2 per cent., but additional moisture accrues under certain conditions by "occult condensation,"—fog and cloud drip, as described by Descombes (9). In this connection Hirata (21) reports 10 to 11 per cent. excess of rainfall catch within forests over that in the open during periods of fog. Nicholson (34), however, reviews the work of Zon (45) and Brookes just cited, and indicates inadequacy of their generalizations when applied to specific conditions, such as exist in East Africa. In a review of Nicholson's paper, the writer (26) stated the conditions under which forests may influence rainfall significantly, and indicated the nature of information required to answer the question scientifically. Suffice it to say, that under the influence of land-ward monsoon winds, forests as contrasted with denuded landscapes play an important part in relaying moisture to the interiors of large continents. Specifically forest vegetation has been shown to influence the effectiveness of rainfall for vegetation by reducing superficial run-off losses. (7, 10, 24, 25.)

(2) Influences of forests on climate were overstated by the early investigators. Becquerel, Woeikof, Blanford, and Lorenz von Libernau, as recent more critical studies have shown (17). On the other hand important influences on micro-climate are being established in studies of forest stands and forest soils (op. cit, and 37). Forest vegetation plays a decisive rôle in succession of vegetation, reproduction of forest tree species, soil fauna, and soil characteristics. In this direction influences of forest and other natural vegetation will receive more and more attention in land use studies and in land management.

(3) Interest in forests, floods, and erosion has been revived in the past decade by experimental studies. Nevertheless divergence of findings in this field exist. Chittenden (6) is still recognized by many as an authority on the subject, although Swain (42) not only effectively refutes Chittenden's conclusions but draws others much

more in agreement with recent experimental findings. Mead's findings on the rivers of Wisconsin (33) as well as those of Burr on the Merrimac (2) are frequently accepted as adequate bases for authoritative conclusions, despite the fact that these studies failed to satisfy the exactions of scientific method.

The two elaborate watershed studies, Emmethal in Switzerland (13), and Wagon Wheel Gap in Colorado (1) failed to show effects of actual denudation in comparison with those of a forest cover. Denudation, such as Cooke (3) thinks accounts for abandonment of Mayan cities in Yucatan, which Surrell (39) and Demontzey (8) combated in the French Alps, and which the writer described in China (23), were in no wise compared with forested lands in the Emmenthal and Wagon Wheel Gap studies.

The run-off plot method employed by Duley and Miller (11) for comparing influences of different crops on run-off and erosion began a new attack in determinations of this kind. The writer employed the plot method equipped with automatic recording run-off measuring devices first in China and later in California. Decisive influence of a mantle of vegetation on surficial run-off and erosion has been established by this method of experimentation (op. cit. 25).

(4) The relation of forests to water supply is more complex and has likewise given rise to contradictory conclusions. The chief reason for the contradictions is that the influence of forests on water supply has been recognized and only observed rather than measured. Catchment areas yielding water supplies to municipalities have generally been retained in forests, or such areas have been planted to forests by common consent and approval. Support of this policy exists where utility and regularity of flow rather than quantity of water control are the first consideration. In western North America the interests of stockmen and irrigationists have clashed. Divergence of findings of effects of range, browse and forest vegetation on total water supply and its utility have been expressed by Forsling (15, 16) and Stabler (41).

It has long been recognized that forests consume relatively large quantities of water which varies widely between species. Ototzky (35) found in Russia that forests depress ground water levels below those of adjacent steppe or grass lands. More recently Halden in Sweden (20) found soil moisture to be less within the forest than in bare lands to depths of 1·0 meter. Exceptions occurred since conditions within forests favoured more rapid percolation of rain water.

Forest cover has been supposed at the same time to increase storage of ground water and to provide conditions for greater regularity of flow and utility of supply (45). But demands on water supply have reached critical proportions in semi-arid regions of rapidly growing populations and of prolonged droughts in more humid sections. In the face of serious water shortages, the desirability of maintaining a non-commercial forest cover has been questioned on the assumption that water losses due to transpiration may be recovered by destroying the forest vegetation. Hoyt and Troxell (22) have presented data of comparative streamflow before and after deforestation in Colorado and denudation by fire in southern California from which such a conclusion is drawn, but fail to present a complete picture of problems facing water conservation in California. The question is complex and essentially regional. Utility,

control, as well as quantity, make up water supply. The question awaits adequate experimental determination for a satisfactory basis of watershed management under conditions of critical supply.

Reasons for Divergence of Conclusions.

A basis for enlightened management of watersheds has not thus far been generally agreed upon for three major reasons,—reasons often lost sight of by past investigators: (*a*) Behaviour of streamflow from a watershed is a resultant of a number of complex interacting factors whose isolation is an extremely difficult experimental procedure. General practice in such studies has been to attempt measurements of influences of a forest mantle,—a single factor—by streamflow from a watershed, which is a resultant of a number of factors. Variable results were inevitable, with the rôle of forest cover inadequately measured ; (*b*) Factors which produce resultants in streamflow are not uniform in operation from place to place ; they vary widely and often in different directions with respect to each other. Such factors can not be treated as chemically pure reagents in laboratory reactions. The factors are now generally known ; their evaluation, however, has not been adequately made ; (*c*) Evaluation of component factors of a watershed complex is requisite to establish relationships of mantles of forest or other natural vegetation to micro-climate, to erosion, to streamflow, its quantity, regularity and control, and to furnish the basis of enlightened treatment of watersheds for water supply. A process akin to an algebraic summation of a number of plus and minus quantities is required for each region.

A Revised Approach to the Problem.

In examining effects of disturbance by man, his domesticated animals, and his machines, upon regimens of streamflow, erosion, and other possible indirect effects upon climate, it is desirable to begin investigations with natural undisturbed condition of landscapes. Such relicts of primeval vegetation facilitate comparative studies. Where, however, no relicts are extant, difficulties and uncertainties surround reconstruction of rates of normal processes. In such cases the most reliable procedure is to set aside areas protected from all major artificial influences, such as the use or destruction of natural vegetation, be it timber or grass, by grazing, trampling, lumbering, fire, clearing, or cultivation. In such areas natural vegetative succession will give within a few years a more accurate expression of the potentialities of control of run-off and erosion of soil, and of other factors under prevailing climate than any other contrivance. Norms of processes under conditions undisturbed by human or artificial agencies or their nearest approximations represent most stable natural conditions and are required for comparative studies of this nature. The manner in which natural controls function furnishes the bases for enlightened management of watershed areas for specific objects in national economy.

Interdependence of Vegetation and Soil.

Soil coatings of a landscape under humid to semi-arid climates are the product of processes of weathering of the original rock material, influenced by climate, through time, under controls of a mantle of vegetation. Vegetation plays a remarkable rôle (18): it accelerates weathering ; it supplies nutrients for myriads of soil micro-flora

and fauna, and for burrowing animals (19, 14); it prevents rapid removal of soil by favouring percolation of rain water, and by protecting soil surfaces from erosive action of wind and flowing water; it yet again tends to retard rates of weathering of underlying rock (40) by favouring accumulation of a thick coating of soil. On the other hand vegetation is unable to develop to its climax without deep soil to furnish site, nutrient supplies, and water storage. A remarkable dependence of long standing exists between soils and their natural vegetation. Development of soil and vegetation has progressed dependently through periods of time often to be measured in geological terms.

The soil coating is at the same time subjected to erosional processes whose operations are reflected in sculpturing of landscapes. Erosional potentials are produced principally by gradients of land uplift, by precipitation, and by soil formation and texture. Under natural conditions within climatic regions supporting complete coverage of vegetation, the soil coating is subjected to the operation of erosional potentials under vegetative restraints. Topographic form represents the operation of erosional processes generated by erosional potentials as affected by geological structure, precipitation, soil formation, and the restraining influences of natural mantles of vegetation responsive to climate. Erosion under these natural conditions has been designated a "geologic norm of erosion" by the writer (27); McGee (32) refers to this concept as "old erosion." More recently the concept is less concisely designated "normal erosion."

Geological Norms of Erosion.

The geologic norm of erosion as a concept is not a uniform phenomenon. It responds to varying supplies, intensities and character of precipitation, to faulting and geological structures, to landslides and to soil-forming processes. It represents inevitable processes of degradation and plantation of land forms above sea level measured in geological time units. Geologic norms of erosion may be reduced by dams for irrigation and other purposes; they may be considered as limits of practical measures of erosion control in drainages without dams and as a basis for measurement of acceleration of soil erosion.

Accelerated Erosion.

Acceleration of erosion above geologic norms is a second important concept. It represents artificially augmented operations of erosional potentials caused by the removal of controls exercised by a mantle of vegetation. Destruction of native mantles of vegetation may be caused by fire, destructive lumbering, heavy grazing, smelter fumes, railroad and highway cuts, and clearing and cultivation for agricultural crops. Perhaps the earliest reference to processes of acclerated erosion is found in Isaiah 7: 23-25. Marsh (31) and more recently Turrill (44), the writer (23), Bennett and Chaplin (4) and others, have indicated effects of destruction of coverage of natural vegetation on accelerating erosion.

Differences between geologic norms and accelerated erosion are of vital importance in national economy. Such differences affect rates of soil removal in relation to processes of soil formation. Soils are rarely destroyed by erosion of geologic norms

or normal erosion. Accelerated erosion on the contrary proceeds at rates greater than soil formation, and destroys the soil. Degree of acceleration depends on continued mis-management of land. In areas, however, where delicate balances exist between vegetative control and erosional potentials, acceleration of erosion may proceed without natural check until utility of soil resources is seriously impaired or destroyed. Accelerated erosion is the chief agent of suicidal agriculture to which the writer has referred elsewhere (28).

Degree of acceleration of erosion through baring lands formerly covered with vegetation is dependent on a number of factors; such as, soil type, soil profile characters, character of precipitation, and climate. Little or no acceleration is caused by run-off from sandhills by removal of vegetation ; wind, however, may set dunes in motion. On the other hand maximum acceleration occurs not in clay soils, but predominately in loam soils, especially when underlain by clay zones or beds. Evidences of acceleration of water erosion appear as gullies in fine rock free soils, and as *erosion pavement* in soils containing rock fragments. More areas of serious accelerated erosion lie in rain than in snow belts. Finally, climate as it may favour or disfavour quick return of vegetation and active soil micro-fauna is an important determinant of degree of acceleration.

Significance of disturbances of delicate interdependence between vegetation, soil and regimens of streamflow upon maintenance of land productivity has been variously interpreted. Conspicuous divergence of conclusions on relative influences of forests and other natural vegetation on streamflow and erosion is to be found in the voluminous literature on the subject, a review of which cannot be made here.

ANALYSIS OF FACTORS.

Water being the principal factor in changes wrought in baring soil surfaces of a landscape formerly covered by vegetation, any experimental study of problems involved must begin with a consideration of supply and disposition of meteoric waters. The following analysis will indicate those points of a complex of factors on which experimental studies have been made and what phases require further study for an evaluation.

AN ANALYSIS OF SUPPLY AND DISPOSITION OF METEORIC WATERS.

A. Supply of meteoric waters comprises :

1. Amount and occurrences as :—
   (*a*) Rain
   (*b*) Snow.
   (*c*) Cloud drip.
   (*d*) Fog drip.
   (*e*) Intra-solum condensation.
2. Juvenile water from hot springs.

B. Disposition of meteoric waters comprises :

1. *Retention*, being :

(*a*) Evaporation from—
   1. Vegetation and foliage.
   2. Soil surfaces.
   3. Soil mass by vapour movement.

(b) Transpiration from—

1. Forests and other vegetation on drained slopes and valley plains.
2. Sub-irrigated valley and canyon bottom vegetation.

(c) Water of combination, to form—

1. Organic substances.
2. Hydrates of oxides and silicates in rock—weathering processes.

(d) Abysmal seepage.

2. *Run-off*, being—

(a) Ground water drainage (springs).

(b) Storm run-off, combining—

1. Shallow seepage or discharge of wet weather springs.
2. Surficial (superficial run-off which represents unabsorbed portions of rainfall or melting snow).

3. *Deep seepage*, or deep percolation which escapes through rock masses without appearing in surface drainage channels.

Storm run-off is the dominant factor in norms and accelerated phases of erosion. This factor likewise causes flooding, protecting against which is costing enormous sums of money. Ratios between evaporation and transpiration determine degrees of influence of vegetation upon water-yield from drainage areas. These are the more specific responses. Influences of forest vegetation or its absence upon absorption of heat from sun rays and its radiation are more difficult to isolate as Geiger (op.cit.) has shown. Only a beginning has been made in determinations that may be of profound importance to enlightened land management for maintenance of favourable local climatic conditions and conservation of soil and waters.

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INHERITANCE OF WITCHES' BROOM FORMATION IN PINE (P. SYLVESTRIS) (VERERBUNG DER HEXENBESENBILDUNG BEI DER KIEFER).

By J. Liese, Eberswalde.

Zeitschr. fur Forst. und Jagdwesen, Vol. 56, No. 10, October, 1933.

By witches' broom formation is meant that phenomenon in which a branch system of a tree undergoes a significant metamorphosis that manifests itself in subnormally shortened internodes and a concomitantly bushy growth and results in a more or less diminished rate of subsequent growth. In addition, the new twigs very often exhibit a tendency to react independently of the normal correlative tropisms of the tree; they usually attempt collectivey to grow vertically upwards, or occasionally extend themselves in all directions from the parent branch, exhibiting no discernible gravitational influence.

We are very well informed concerning the causes of witches' broom development as in very recent times, Prof. Baron von Tubeuf who has worked with this problem for a long time, published a thorough-going contribution on the subject (Zeitschr. für Pflanzenkrankheiten and Pflanzenschutz. (Pflanzenpath.) Vol. 43, 1933, pages 193-242). According to Prof. Tubeuf, most of the indigenous witches' brooms are traceable to parasitic influences, among which fungi, next to mites, are most important. Among the witches' brooms of the deciduous tree species, the Exoascus species rank at the top. The witches' broom of silver fir (*Abies pectinata* D C), which simultaneously produces at the point of infection the so-called silver fir canker, also is caused by a fungus (*Melampsora caryophyllacearum*).

But for a long time the problem as to the cause of spruce and pine witches' brooms remained unsolved since fungous and other parasitic irritators were not found and evidence that tended to prove the contrary was refuted upon counter-investigation. Von Tubeuf first succeeded in establishing the fact that spruce witches' brooms were occasioned by growth modifications induced by internal disturbances. He succeeded, at three different times, first in 1907 and twice through repetition of the experiment in 1930, in producing progeny from the seed of spruce witches' brooms which developed, to the extent of 27·7 and 38·5 per cent. in the last two experiments, the same bushy,

witches' broom-like growth. Thus the proof of transmissibility was indisputably established and the witches' broom phenomenon in spruce is to be classified, therefore, as a bud mutation.

It was assumed that the same explanation as to the development of witches' brooms was applicable in the case of the pines, although the evidence of precise experimentation was lacking. The reason for the latter lay in the fact that cone bearing witches' brooms in pine were none too frequently available to the scientific investigator; the significance of experimentation in this field was little known to the layman. In response to a request some cones taken from pine witches' brooms were supplied me about three years ago by Diplomforstwirt Baron von Werthern of Hoppenrade. The number of cones was limited and they were small in size and yielded only a few seeds. In addition, in the raising of the seedlings several were lost when attacked by *Moniliopsis klebahni*. Nevertheless, it was possible to save eight plants for further study. Among these an appreciable difference in the growth habit was recognizable even in the two-year old plants and during the third year this difference was still more pronounced. Three of the plants exhibited the normal growth habit of the pine, but the other five developed quite completely the witches' broom habit of growth. In both similarity and variations of development there is a striking uniformity between the plants which checks with what von Tubeuf pointed out in his last publication on spruce. No doubt can exist, therefore, that in the case of pine as well as spruce, the abnormal witches' broom habit of growth is to be considered as a mutation and is transmissible to the offspring; that not all of the progeny are of the witches' broom type can be readily attributed to the fact that nothing is known of the origin of the pollen and, therefore, of the masculine progenitor. It is very likely that most of the pollen comes from staminate flowers that grew on normally developed branches. It is remarkable, therefore, that in this experiment considerably more than one half of the pines are of the witches' broom type.

Essential differences between the healthy and witches' broom pines occur also in the development of the root system. This is evident when entire root systems of 2-year-old normal and witches' broom pines are compared. In every respect the root development of the witches' broom pines is inferior to that of the normal pines.

As is well known, and as the numerous photographs that illustrate von Tubeuf's work so excellently depict, witches' brooms of pine, as well as spruce, exhibit no uniformity in their development. There are to be found witches' brooms, recognizable as such from a distance, with unusually dense branches; on the other hand, there are also "brooms," whose shape, as compared with that of normal branches, show only minor variations and the question may well be raised whether or not a witches' broom condition is involved. While typically dense witches' brooms, as a rule, very rarely bear cones, which necessarily limits the possibility of the transmission of this particular habit of growth, the lesser developed "brooms" are much more prolific cone bearers, and are thus more abundantly represented in the reproduction through the seed produced by the diseased trees. To what extent the stunted growth habit is transmitted by the latter kind of witches' brooms is not yet known, neither is it known as to whether or not the percentage of representatives of offspring is less in cases

of this sort. On the other hand, it is well known to every forester who has worked in a pine forest that in artificial plantations individual plants quite often remain stunted in form and never develop normally ; as a rule they subsequently die off. Heretofore, it has been the practice to attribute such development to parasitical influences and not to ascribe to it any particular significance. Further investigations on witches' broom pines are necessary to clarify this phenomenon. It will also be interesting to study the offspring of normal branch systems of pine trees infected with witches' brooms, to see if there exists in these likewise a definite tendency toward witches' broom mutations that is, in part, inheritable by the offspring.

It may be possible later to provide definite information along this line since additional breeding experiments are now under way, in which the seeds from cones of less typically developed witches' brooms have been used. In any event, it will be appreciated if, in the meantime, mature cones from pine witches' brooms are forwarded to me accompanied by precise descriptions as to the size and density of the "brooms" from which the cones were obtained.

ADDENDA.

The conclusions of Dr. Liese are sustained by T. J. Hintikka in a contribution entitled "*Muutamia haraintoja männyn tuulenpesista (Contribution to the knowledge* of witches' brooms in pine)" appearing in Acta Forestalia Fennica, Vol. 39, 1933. The conclusions derived by Hintikka from his studies, which were presumably conducted independently and without knowledge of those of Liese, are :

1. The development of witches' brooms in pine (*P. sylvestris*) is an inheritable characteristic to the extent that certain trees raised from the seed of witches' broom cones manifested witches' broomlike growth.

2. In this witches' broom development a very definite nanistic tendency is displayed, so that one is justified in interpreting the development and formation of witches' broom in the pine as nanism.—[J. ROESER, JR., *U. S. Forest Service.*]

(*Journal of Forestry*. May 1934.)

DRY ROT IN BUILDINGS.

(By J. Greaves Scholes, F.S.I.).

The following few notes on the cause, symptoms and treatment of dry rot may prove of assistance in detecting its presence at an early stage, and in giving effective treatment to check its growth before great damage has been done.

Causes.—The primary cause of dry rot is enclosed, or partially enclosed, moisture, in wood. Light and ventilation are its greatest enemies. If unseasoned or damp wood is painted or so covered that the moisture cannot dry out, a suitable breeding ground for the fungus is provided.

One of the most frequent causes of dry rot is the lack of ventilation under boarded floors. It is not sufficient to have ventilation bricks in two external walls of a room when the two internal sides are cut off by passages or rooms having solid floors.

There will always be a pocket of stagnant air in the angle between the two internal walls. This can be avoided by the provision of one or more air-ducts under the solid floors to give through ventilation from one side of the house to the other.

Care should always be taken that such ventilating bricks as exist are kept open and that the outside soil is well below the damp course in the wall.

The total covering of a floor with linoleum, especially a wood-block floor, may cause dry rot on account of the upper surface of the wood being almost hermetically sealed.

Symptoms.—Dry rot in its early stages is not easily discernible, as darkness is one of the most favourable conditions under which it thrives. It can therefore grow and spread considerably in such places as behind skirting boards, door and window linings, wainscoting, wood panelling on walls or in joists, and the underside of floorboards, before any outward signs of its presence appear.

The growth of fungus on woodwork or out of its joints is, of course, easily seen. It may appear in the form of a velvetty mould, generally light grey in colour, or in thin tendrils, somewhat resembling a miniature tree pressed flat. This latter is generally found behind woodwork such as skirting boards, etc., or on a wall in a dark place.

Another outward sign is the appearance of a corrugated or wavy effect on painted woodwork, which eventually shows cracks. In this case it will often be found, when the woodwork is removed, that little more than the painted surface remains, all the timber behind having crumbled away.

Generally speaking, the person best situated to discover the symptoms of dry rot is the one who does the cleaning, dusting, polishing, etc., of the woodwork.

Another means of discovering the presence of dry rot is to tap the woodwork with a hammer ; if the wood is sound it will ring hard and firm and the hammer rebound, but if badly decayed underneath it will appear dead and dull to the blow.

A stout knife-blade pressed into the wood will reveal the presence of decay. If the wood is sound the blade will not enter or leave easily ; if it is decayed, the reverse is the case. In all cases where dry rot is suspected the woodwork should be removed and a careful examination made underneath.

Treatment.—The only satisfactory means of eradicating dry rot is to remove all the material which is in any way affected by it. This is comparatively simple, though sometimes costly, in the case of timber. Great care should be taken that every particle of affected wood is removed and burned ; it is always advisable to be generous in this removal, and to take away a little more than that which is actually affected. Great care should be taken that all woodwork which is let into the wall, such as plugs, etc., is removed, as this is very often the source of trouble. The vacant holes should be well scraped out and all fungus and decayed wood carefully removed

Unfortunately, dry rot is not always satisfied with wood, but attacks the brickwork and plaster as well. In some cases it is content to operate on the surface or between the brickwork and the plaster; in other cases, and these are much more serious, it penetrates into or through the brickwork.

Where dry rot is found on walls the part affected should be thoroughly scraped. If plastered, some plaster should be removed to ascertain if there is any fungus growing between the plaster and the wall. The joints of the brickwork or masonry should be raked out ¾ inch deep. It is a useful precaution at this stage to use a plumber's blowlamp to heat the wall to such a degree that any remaining fungus is killed. All material accumulated by scraping or raking out joints should be carefully removed and sterilised by fire or other means to prevent infection.

The whole of the surrounding material must now be sprayed or well brushed two or three times with either corrosive sublimate or acid magnesium silicofluoride, care being taken that the liquid gets well into all openings or cracks. After this treatment the raked-out joints in the wall may be pointed up with cement mortar (two parts sand to one of cement), or, if they are in a cellar or other similar situation, they may be left open for a time and watched for possible recurrence.

All new timber which replaces that taken out and which will be covered in, such as joists, plugs, etc., should be thoroughly treated with creosote or other suitable wood preservative before being fixed.

A few words on the characteristics of the two spraying liquids may be helpful.

Corrosive sublimate is highly poisonous. Great care should be taken in handling it. It is probably more easily obtainable than acid magnesium silicofluoride, and can be used in a metal spray. Two ounces should be dissolved in one gallon of water. It is more effective when applied hot.

Acid magnesium silicofluoride is not poisonous, but highly corrosive. It must not be put in a metal vessel or spray, and should be mixed in a wooden tub and applied with a brush. If used on exposed surfaces a certain amount of efflorescence may appear; its penetrative powers are greater than those of corrosive sublimate, and it is therefore probably more effective. Half a pound of acid magnesium silicofluoride should be dissolved in one gallon of cold water.

A treatise has been published by the Department of Scientific and Industrial Research, entitled "Dry Rot in Wood." This can be obtained from H. M. Stationery Office for 1s. 1d., post free. The information contained in this pamphlet goes into considerable detail, and I should certainly recommend anyone who is attacking dry rot to obtain a copy.

There is another form of decay which is sometimes mistaken for dry rot. This is caused by the ravages of a grub or beetle. A number of tiny holes appear in the wood as if a very small drill had been used, and powdered wood, like dust, is expelled. Sometimes the holes are so close together that the walls dividing them collapse, making it appear as though the wood had decayed. Badly affected wood should be replaced, though there are preparations on the market now, such as "Rentokill" and the "Hopewood Worm Destroyer."—[*The Builder E. R.* 2626 *F.*]

(*Indian and Eastern Engineer*, March 1934.)

TOUR JOTTINGS IN MADRAS.

By H. G. Champion, Silviculturist, F.R.I., Dehra Dun.

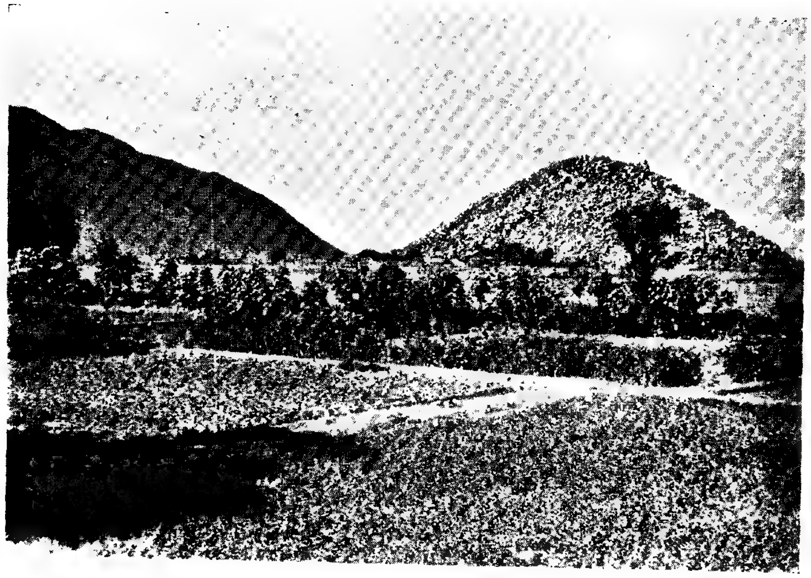
A whisper has reached me that the descriptive word "Jottings" used as the title of a recent article about a tour in South Bengal was considered by some readers to be misleading. Serious matters such as the scientifically conducted measurements in sample and experimental plots, the deductions made from them, and the practical application of the general results are "recorded" not "jotted," I gather so that if the title is maintained, the subject matter should deal at least mostly with those general impressions and minor happenings to which the more vernacular word is appropriately applied. Whilst admitting the charge, I should however like to remind these critics that foresters are notoriously addicted to talking "shop," and this is obviously permissible in the pages of the *Indian Forester*. When one is talking shop, the light and serious sides inevitably get mixed and in these notes the usual mixture is likely to recur.

The tour in question was made at the beginning of 1934 with the Madras Silviculturist, and occupied some ten weeks in all, including time spent in the Indian States. The first day was marked by a most inauspicious omen, an earthquake -or rather, *the* earthquake—but the management of bamboo forests was proving so engrossing a topic at the time that the warning went completely unheeded, in fact, I only heard about it on reaching Delhi two days later. I have rarely had so strong a reminder of the climatic difference between North and South India in January, as on the journey southwards; three nights on the train, the first calling for woollen clothing, a great coat, and all available bedding, the

second for a mere couple of blankets and the third, little more than a sheet. I had provided the booking clerk at a station in the north with a couple of hours' hard work discovering the correct route to Kodur and calculating the fares for me and my orderly but this did not prevent his confrere at Kalyan from having another couple of hours at it, and reaching the conclusion that he was not sure whether the tickets were made out for Koduru or Kadur, and anyway I had paid too little on the one ticket, and too much on the other. My suggestion that we should call it quits, and I should go to whichever place I wanted, rather shocked his reverence for the rules, but at least I got my way.

The plan was to continue the tour after Kodur by motor, and indeed there is nowadays almost everything in favour of this method of travel for the visiting forest officer, though a few additional controls are still required such as a weather control and a mud control. Actually my companion had done what he could in this way, for knowing how soft the living is at Dehra Dun, he had fitted wide low pressure tyres for the occasion and had a gadget on the dash board which was understood to control the gradients. That car carried us both, our kit and a servant, and I greatly regret to hear that it has expired since, at a ripe old age. It really carried us extraordinarily well and even when it was doing rather under a mile to the gallon, as happened once, it did its best to let us know with pitiful chokes in its breathing. We may have done various short runs in other cars, in fact we did one such in what I was told was the local hearse, but on the long distances it was always the old Chevrolet.

When travelling in the south, one of the first things one has to do is to accustom one's mind—and one's tongue as far as may be—to long names. Even the coiners of names for small insects only occasionally shoot at one words like Koduvengammabhava, and they don't expect one to remember or repeat them. I was rather surprised that a system of abbreviations, such as K. V. B. for the above example, was not in more general use.



The result of denudation on granitic hills. On the left, the hills still carry an adequate cover of deciduous forest but this has been destroyed on the hill isolated in village lands with resultant erosion of all the soil. Rainfall 40″.
Vanganbadi-Alangayam Road, Mile 7, Vellore Division, 28th January, 1931.

Rab sowings in dry fuel forest coupes showing *Cassia siamea* two seasons old.
Rab 98 Nagararam Coupe II, South Cuddapah Division, 23rd January, 1934.

One subject at least seemed to be interesting most of the south more than forestry and that was Test Matches, but among the visiting players were some who had no intention of missing their chance of seeing an Indian forest and acquiring a shikar trophy or two, though ideas may have varied as to what constitutes a presentable trophy.

This tour gave me my first acquaintance with the drier districts of Madras, including the redsanders forests, and though I have seen many more attractive types, they present plenty of interesting problems. Foresters generally would like to hear more about the success or otherwise of the big scale handing over of forests in this region to *panchayat* management but very little information is available as officers with local experience before the change have not had the opportunity of making critical examinations of the present conditions after some years of village control. The risks of denudation are obviously very great as one of our illustrations (Plate 9) shews, and careful records ought to be maintained (with photographs from fixed points) over a period of years to bring out what is happening in this respect. As regards the villager's immediate interests, it appeared that in some places at least he has to pay more for his grazing and gets less than he did before, so that restoration of Forest Department control would not be unwelcome. Apparently, no professionally trained forest officer is at present concerned with the control of these extensive forests, though originally there was provision for this.

A noticeable feature of the last few years in these drier forests has been the successful application of the Bombay "rab" method of improving the stocking, particularly as regards the proportion of the superior species, by the artificial regeneration of patches or strips on which the felling refuse has been collected and burnt. It is much too early to pass any final judgment on this type of work, and the financial side still requires careful examination, but the early growth obtained is most promising in many places. A species of increasing popularity throughout South India for work of this

sort is *Cassia siamea* which shows a phenomenal rate of growth (Plate 9). A point to be remembered in regeneration work in dry climate is that moisture being the limiting factor, even nature fails in an unfavourable year, and a species or method cannot fairly be condemned on account of failure at the first trial; an experimental garden at Chittcor in which a lot of careful work was done in 1932 with a minimum of success, is a case in point.

The use of tree loppings as green manure (Plate 10) is a destructive habit much more widespread in Peninsular India than in the North, and has had a very great influence on the survival of the forests and their present composition and appearance, not only in the dry forests we have just been considering, but likewise on the Malabar coast with all the rainfall one could ask for. With present agricultural methods, it is a very real need, and either the methods will have to be changed or our forest management will have to provide for it, and even, as with shifting cultivation, try to turn it to good purpose by directing and restricting it to such growth as can be removed to the benefit of the remaining tree crop.

Turning to teak problems, the most important and interesting development is the dissipation of the cloud which for more than a decade has been hanging over the second rotation crop. It can now be taken that by suitable tending and regeneration methods, the second teak crop can be got started without the apparent drop of a quality class which we have hitherto had cause to fear would occur. There is still plenty to learn about the suitable tending, and here only an idea will be mentioned which has been under trial for the last two or three years and is looking promising, *viz.*, the simultaneous sowing of a little rosewood seed with the teak a foot or so away from it. Stump planting is catching on and as described in a recent number of the *Indian Forester*, early work seems likely to result in a big gain in suitable localities. A matter which calls for closer attention is the prevalence of forking in some plantations: personally, I suspect defoliation to be the ultimate cause, but if it is faulty tending technique, the defect should be discovered and remedied. The proposed "replicated" thinning plots in young teak,

Green manuring paddy fields. In the foreground fresh loppings are being spread and ploughed in. Behind they have been 10 days or so in the cow sheds.

Kodur, South Cuddapah Division, 23rd January. 1934.

will be the first of their kind in India and can safely be predicted to yield very valuable information in due course.

Another Madras speciality is the so-called gap regeneration for artificially restocking the gaps caused by selection fellings in both deciduous and evergreen forests, aiming at maintaining or improving the value of the forests worked over both as regards stocking and the proportion of the valuable species. Judgment must be reserved, but the problem seems once again to be primarily a financial one. The work directly and indirectly costs money; does gap regeneration give as good a return on the outlay as the other alternatives open to us, even making an allowance for assumed deterioration of the felled over areas? A preliminary very rough estimate seemed to indicate that granting its silvicultural feasibility, the gap regeneration seen in the mixed deciduous forests requires a stronger case than has so far been made out for it.

Whilst extraction work from the tropical evergreen forests is now in progress only on a very restricted scale, a good deal of experimental work is being done to find practical regeneration methods, a very sound policy. The problem is a very difficult one indeed, and a great deal of patience and sustained effort is called for. The maintenance of a selection type forest of mixed species is favoured, so the object of the experiments is to get up regeneration where it exists —unfortunately it is decidedly localised—and to induce or introduce it where it does not exist.

A great deal of the mixed deciduous forest of the moister parts of Madras is practically certainly secondary to an evergreen forest climax which has been displaced by shifting cultivation, fires and similar agencies. It is particularly in these forests that the very extensive underplanting and sowing with *Hopea* has given most promising results; the experiment was a bold one, even a rash one considering the scale on which it was made and the data there were to go on, and it is far from concluded yet since the *Hopea* remains in the underwood beneath a mixed upper canopy of little value, but it does look as though it may well be justified by results. On the other

hand, the condition of the scattered teak plantations existing in these same wet type forests does not justify great optimism as to their future, despite a not unusually excellent growth at first. Moderate scale trials with the valuable evergreen species and perhaps a cover crop such as have been recently described from Chittagong, would seem more worth the trouble.

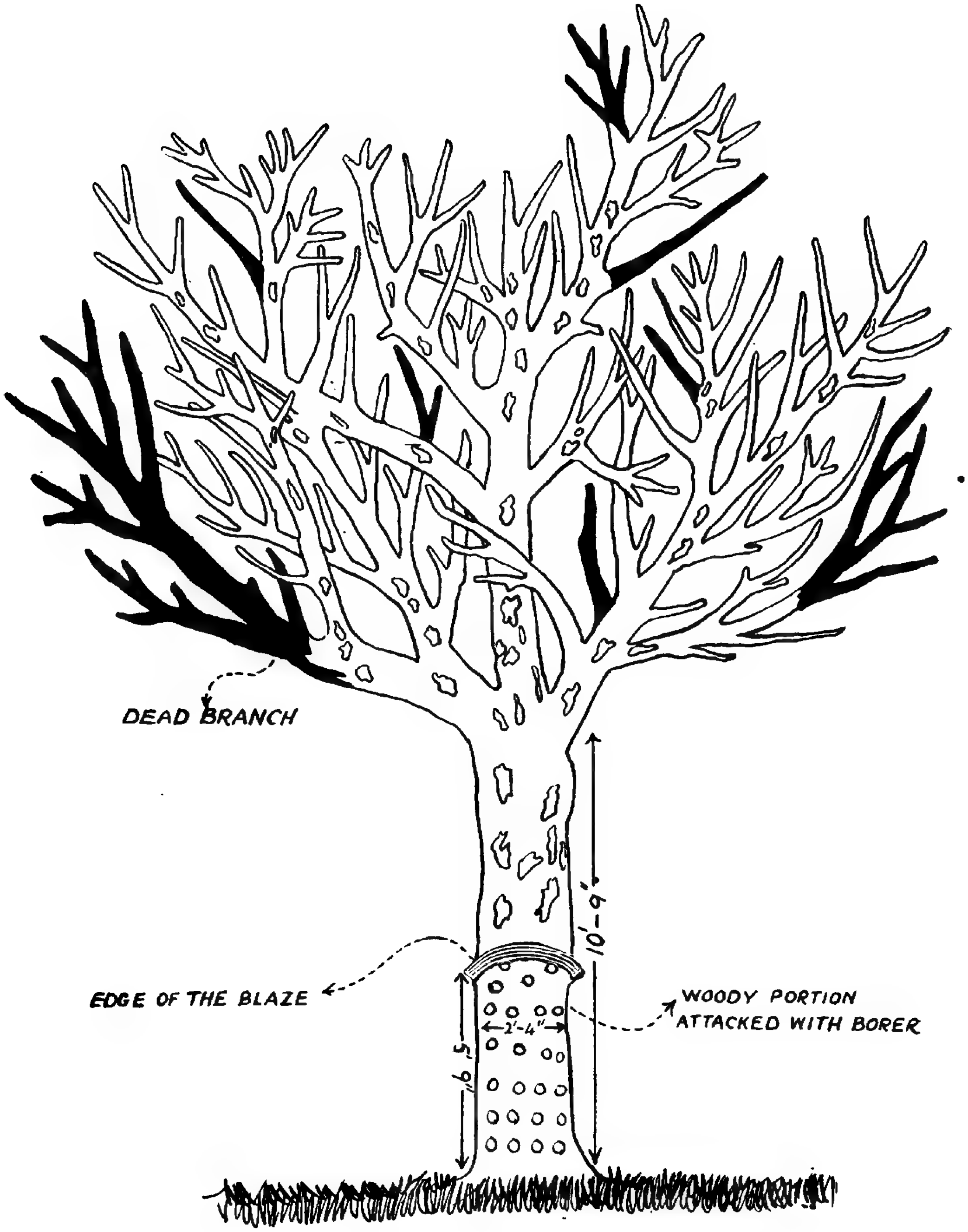
The final jotting to be made here is one to the effect that silvicultural research work in Madras has been effectively modernised in the last few years ; it can stand comparison with any other province in India, and can give points to all in certain directions. But the field for investigation is exceptionally wide and more could be done by the territorial officers with the help of the research staff on the purely technical details of lay-out of plots, methods of record, etc. The good work done by individuals provides an indication of how much more might be done.

KULLU (STERCULIA URENS) WAILINGS FROM DAMOH, C. P.

By Kesar Singh, P.F.S., D. F. O., Damoh, C. P.

Present and Past History.—About five years ago I was considered one of the most useless species in the C. P. forests and consequently conspicuously perched high up on rocky hillsides. I considered myself immune against the depredations and ravages of mankind and was leading a very undisturbed and peaceful life and watched with complacency the heavy fellings and wholesale infection of *ghont* (*Zizyphus xylopyra*) trees going on on all sides of me.

2. All of a sudden however a keen demand arose for my gum for the manufacture of crepe, sizing cloth, and some medicinal purposes with the result that a regular campaign for tapping me mercilessly started and for about four years the gum contractors were given a free hand in dealing with me in any way they liked. Reckless and ruinous tapping by these unscrupulous contractors now reigned supreme and illicit tapping and extraction were the order of the day.



Typical specimen of ruinous tapping of *Sterculia urens* in Damoh, C.P.

In view of the high prices obtained for my gum the whole atmosphere seemed to be surcharged with an insatiable desire to collect my gum without paying any regard to my life and safety. This unbridled tapping was not confined to the adults (mature trees above 4 feet in girth) but was extended to the future generation as well, comprising tender poles and saplings below 3 feet in girth.

3. After a couple of years' working my deplorable condition appealed to the sense of justice and magnanimity of mind of a Forest Officer who introduced certain restrictions to control the tapping and prepared a scheme under which I was supposed to have a four years' rest after tapping, but these things remained only on paper and were never strictly enforced because even in the areas closed to tapping under the scheme heavy tapping and illicit extraction of gum continued with the connivance of the Forest Guards and Range Assistants, and petty contractors of small *malguzari* area having only a limited number of trees used to quietly purchase the gum extracted from the closed areas and in some cases the *malguzari* contractors used to offer fabulous prices for trees in *malguzari* areas in the hope of extracting gum illicitly from the Government Forests.

4. As a result of these nefarious activities, hundreds of trees began to die both in *malguzari* and Government forests and I felt quite helpless, with death and destruction staring me in the face. For a time the situation looked very ugly and savoured of utter ruin and annihilation for me, but with the advent of 1934 a new era dawned with a radical change in the policy of administration, and the Forest Officer in charge, being impressed by the appalling state of affairs, hastened to explain the gravity of the situation to the Deputy Commissioner and invoked his assistance in putting a stop to the above activities. It goes much to the credit of the Deputy Commissioner that he grasped the situation at once and promised assistance. He issued an order to the Magistrates to deal with *kullu* theft cases strictly, and wherever warranted by circumstances to award sentences of imprisonment. He also ordered Section 202 to be brought into operation at once against the *malguzars* as well as the *malguzari*

contractors. Almost all the *malguzari* areas were examined by Forest Officers without delay, and reports were submitted to the Deputy Commissioner for requisite action. As a result of these reports, proceedings were instituted against no less than 145 *malguzars* and contractors.

5. The Forest Department also rose to the occasion and started wholesale punishment of subordinates found guilty of not detecting and reporting heavy illicit tappings and extraction. This had the salutary effect of infusing a sense of responsibility into the subordinates who at once started regular patrol and detection of cases of illicit tapping, and as a result no less than 16 cases were taken into court within four months, of which seven resulted in conviction, three were acquitted, four were withdrawn and two are still pending in the court. In two cases a sentence of three months' rigorous imprisonment was awarded for a theft of eight and two *chhataks* of gum, and in other cases adequate fines were inflicted. In addition 29 cases were compounded and heavy compensation levied. These stringent measures went a long way to stem the tide of wholesale illicit tapping and wanton destruction and I heaved a sigh of relief, because, but for this strong action, my days were numbered and I was likely to be obliterated from this Division in the course of the next few years. Though the damage done to me during the past five years is immeasurable and in certain areas irreparable, in most of the areas I still hope to survive provided adequate measures are taken for my protection for which I appeal to the Government and the Forest Department.

6. *Method of Tapping.*—My request is that my life and existence may not be allowed to be sacrificed on the altar of money and this can best be assured by collecting my gum departmentally, but if on account of financial stringency this is not possible, I pray that the following restrictions on tapping may be enforced :—

(*i*) *Kullu* trees over three feet in girth at breast height should be blazed, the blaze to be so cut that the edges will slant so as not to allow water to collect in the blaze and cause rot.

(*ii*) No *kullu* below three feet in girth at breast height should be blazed. For every undersized tree blazed the lessee will be charged Rs. 2 on account of damage.

(*iii*) No *kullu* tree should be blazed in more than two places during the currency of the contract. These blazes must be on opposite sides of the tree and must not be made within six inches of any old blaze present on the tree. No new blaze shall be larger than 12 inches by 12 inches. The enlarging of existing old blazes must be strictly prohibited. Old trees which have been heavily blazed in the past may not be blazed again during the currency of this contract.

(*iv*) The contractor must not send coolies into the forest for blazing the trees unless they are accompanied by a responsible agent or mate. Collectors of gum must be given passes by the contractor to show that they are really working for him.

(*v*) The contractor shall be liable for any damage or fire caused by agents or coolies.

7. The method of tapping at present in force does not appear to be suitable, because directly the woody portion of my stem is exposed a borer sets in at once and goes on working gradually throughout the stem and so weakens the inner structure that I am easily blown over. I think it would be worth while devising a method by which my woody portion is not exposed during tapping operations.

The system in force for collection is by means of two blazes on opposite sides of the stem, which are four inches by four inches to commence with, and these are supposed to be gradually extended to one foot by one foot, but hitherto they have invariably been much wider and the top and bottom edges are scraped more heavily than the lateral edges. The exudation of gum is greatest within the first 24 hours of blazing and continues for a couple of days. The gum secreted on the edges thickens within a day or two in the shape of paraboloids, globules, and thread-like streaks of various sizes which

are picked off by the collectors who visit each tree every third or fourth day. After a couple of days the pores get clogged and with a view to accelerate the exudation the edges of the blaze are slightly scraped and usually an $\frac{1}{8}$ inch scrape is quite enough for this purpose. The exudation of gum is reported to be greatest in October and November and again from April to June and the gum obtained during this latter period is also of the best quality. The gum collection usually commences from 1st October and continues till the break of the rains. The gum obtained may roughly be classified as under and is usually sold at different rates according to quality :—

			Average price.
1st quality	Pure white in colour	..	Rs. 40 per maund.
2nd do.	Slightly dirty	.. ..	25 ,,
3rd do.	Very dirty ..	.. ..	15 ,,

The rates of collection paid to gum collectors usually vary from -/2/- to -/4/- per seer according to the quality of the gum and the rate prevailing in the market.

8. As regards the *malguzari* areas, the following rules and restrictions should be issued by the Revenue authorities :—

(1) The proprietor should report the approximate number of *kullu* trees in his areas and from the number of trees it will be possible to obtain some idea as to the approximate quantity of gum available from that particular area.

(2) No gum should be extracted by coolies or purchased by lessees between sunset and sunrise.

(3) The purchaser should keep a register of receipts showing the names and addresses of the persons who bring the gum and the quantity received, and this register should be open to check and inspection by any Forest or Police Officer.

(4) The gum should be taken to markets for sale along fixed routes under the cover of *malguzari* passes, which may be checked by any Forest or Police Officer, and counterfoils should be checked by any Forest Officer at any time.

(5) After one year's tapping every forest should be closed to tapping for four years.

In addition, the restrictions proposed for Government forests in paragraph 6 should also be made applicable to *malguzari* forests.

9. *Yield and Value.*—I need hardly mention that I am not inferior in value compared with any of the more important timber species and therefore I should be entitled to special protection at the hands of Government. On an average I yield about five seers of gum per year which according to current rates is likely to fetch Rs. 2/8/-. I can safely give about five tappings in my lifetime, therefore on an average my value comes to Rs. 12/- per tree which does not compare unfavourably with that of any of the more important timber trees. The yield of the red-barked species appears to be much higher than that of the white-barked species and trees situated on hill slopes are said to give a better yield than others.

10. *Miscellaneous.*—To my great dismay and disappointment I find it that my young regeneration is conspicuously absent in the areas subjected to heavy tapping which shows that tapping affects my vitality and consequently the fertility of my seed which usually becomes sterile from excesssive tapping.

Under such circumstances, it appears to be necessary to reserve about 20 per cent. of the trees against tapping and this reservation should be strictly enforced. It is also essential that I should be given four years' complete rest after one year's tapping.

(*Overheard and recorded by Sardar Sahib Kesar Singh.*)

DENUDATION ON THE CHHOTA NAGPUR PLATEAU.

(BIHAR AND ORISSA.)

By L. R. Sabharwal, I.F.S.

The province of Bihar and Orissa can be conveniently divided up into three topographical regions, a central highland which forms a main water-parting, a northern plains area, and a southern area containing numerous mountains and several rivers which flow direct from the province into the Bay of Bengal.

2. The central tract is a region of broken plateau land and mountainous spurs which are the eastward termination of the huge Satpura hills. Chhotanagpur lies in this central tract and comprises five districts :—

			Sq. miles.
Ranchi	..	..	7,000
Palamau	..	..	5,000
Hazaribagh	..	..	7,000
Manbhum	..	..	4,000
Singhbhum	..	..	4,500
	Total	..	27,500

The two main plateaux, those of Ranchi and Hazaribagh are each about 2,000 feet high, separated by the deep valley of Damuda and carry, especially on the west, still higher plateaux (usually 1,000 feet higher) which are known as *pats*. It might be remembered in passing that it is on one of those *pats* that Netarhat (3,500 feet high) which was intended for a sanatorium is situated. It has not become popular, however, owing largely to its inaccessibility. One of the outlying ranges extending across the boundary of Manbhum and Hazaribagh contains the highest mountain in the province, the Parasnath —4,430 feet high. Manbhum is practically the last step in the descent from the elevated plateau of Central India to the delta of lower Bengal; the Chhotanagpur plateau with its general elevation of 2,000 to 2,500 feet forms the intermediate stage.

3. The basis of the Chhotanagpur pleateau geologically is the Archaen or Bengal gneiss. The greater part of the area shows exposures of the rock itself or the immediate products of its decomposition, the rock dips under the alluvium of the northern tract. Excellent examples of the "domegneiss" may be seen on the Purulia-Ranchi road. Gneiss gives rise to a reddish stiff loamy soil, well suited to the growth of forest while kept covered, but bakes to a brick-like hardness when denuded. Laterite occurs principally as a cap to the higher hills.

4. Before discussing the causes and effects of denudation it would be interesting to say a few words on the existing state of forest and the stage of denudation in the various districts.

Ranchi.

Undoubtedly the whole area was once covered with jungle, but now the whole centre of the plateau has been cleared and there only remains a fringe of forest covered hills. Cultivation, however, extends up the slopes of the hills and *jhuming* is practised extensively. That denudation has made rapid progress during the past is beyond question. Wherever the smallest area of flatter ground occurs or where there appears to be the remotest chance of raising any sort of crop, however poor, the forest is at once hacked down and burnt and the crop is raised with the help of the fertilising matter thus obtained. But due to the source of supply of such ingredients having been destroyed, such fields can only be of the most temporary utility; in practice they only produce crops for one or two years. The areas are then left to themselves when owing to the enhanced erosion of the soil and perennial fires they soon become totally unproductive and incapable of supporting any growth whatsoever.

Ranchi has special importance as regards rivers. The Subarnareka flows through it, the northern Koel rises in it and flows through Palamau, the southern Koel and the Sankh which unite in Gangpur and form the Brahmini both rise in Ranchi and the Karo which eventually joins the southern Koel is also of some importance. These rivers flow red and thick with mud and silt washed from the denuded plateau during the rains. That denudation should have been allowed to go on in this district which forms part of the catchment area of so many important rivers is most unfortunate.

There is no record of famine before 1897. Since then there have been three famines, all in the area where denudation has been more recent. The reason is obvious. The people living in the vicinity of forest could get edible roots and fruits from it, while those living away from the forests were cut off from these supplies and had to suffer privation.

The extent of denudation which has taken place in Ranchi district during the last 30 years can be accurately assessed by analysing the figures given in the survey and settlement operations (1902-10) and those supplied by the Settlement Officer from the records of the settlement just completed. The total area under forest (culturable as well as unculturable) was 2,280 square miles in 1902-1910 against 1,960 square miles in 1932-33. In other words 320 square miles have been brought under the plough during the last 30 years. When it is realised that the greater part of the area of 320 square miles cleared for cultivation is situated on the slopes of hills, the significance of denudation can well be imagined.

Unfortunately such comparative figures are not available in other districts of Chhotanagpur. If they were, there is no doubt that a similar tale would be revealed in their case also.

Manbhum.

This is the most developed of all the Chhotanagpur districts, it was the first to be opened up by the railway and here denudation is most complete. There is very little forest in the north and a fringe round the south : the forest which has escaped total destruction lies in inaccessible places in the south. On account of heavy demand this forest is also reduced to scrub now. The centre of the district is absolutely bare.

Everyone who knows the district is convinced of the widespread denudation. The settlement report (1918 –1925) says that there are some 700 square miles of jungle within the district. This figure not only includes culturable jungle which can not be less than 300 square miles, but also extensive ranges of bare hills of gneiss, grass lands and other useless areas which are unfit to support any kind of vegetation whatsoever. The extent of denudation can be imagined when it is realised that most of the area (4,000 square miles) of the district was once covered with well-stocked forest. On account of extensive denudation this district is devoid of any picturesque views and a traveller meets with desolation everywhere, bare gneiss hills being a characteristic feature of the countryside.

There is only a very small area of protected forest known as Matha forest range under the Forest Department. Small forests belonging to the Encumbered or Court of Wards Estates have been reserved in the past but as soon as the Estates were solvent or the minors attained majority, the notifications declaring them reserve forests were cancelled. Considering that it takes generations for ruined forests to recover, their reservation for a few years only, as has been done in the case of most of the forests in Manbhum, has been of little or no use.

Palamau.

There are some 250 square miles of reserved and protected forests in this district. The Government reserves form a more or less compact block in the south of the district. The larger portion of the district is under private forests.

Hazaribagh.

The destruction of forests has been in progress for a very long time. The forest has been wastefully destroyed and it has been reported that plants of botanical and economical interest are disappearing. In the north of Barakar basin there are extensive areas where all jungle has entirely disappeared and elsewhere in many places the repeated cutting to which the sal has been subjected in order to obtain timber for house-building, etc. has transformed what was once a mixed sal forest into one of thorny shrub.

In spite of all the destructive forces at work, there still remains a fairly large area covered with jungle. The slopes from the plateau are too steep for cultivation and are comparatively inaccessible and some of the hills which are scattered about the district still contain scrub forest. Government have a small area of reserved and protected forest (103 square miles), which forms part of the Palamau forest division.

Singhbhum.

It is in this district that the best and extensive sal reserved forests under Government control lie.

Part of the district known as Dalbhum however contains no forests under Government control with the result that serious denudation has taken place here. Dalbhum is important inasmuch as it forms part of the catchment area of the Subarnarika and there are many hills containing scrub forest unfit for permanent cultivation.

The total area of forests under Government control in the plateau area is shown below :—

Name of district.		Area of district sq. miles.	Area of reserved forest.	Area of protected forest.	Total of columns 3 and 4.
1		2	3	4	5
Ranchi	..	7,000	2	..	2
Manbhum	..	4,000	..	14	14
Hazaribagh	..	7,000	67	36	103
Palamau	..	5,000	225	24	249
Singhbhum	..	4,500	733	303	1,036
Total	..	27,500	1,027	377	1,404

The figures speak for themselves. Practically the whole of the area under Government control lies in Palamau and Singhbhum districts while in Ranchi and Hazaribagh districts which constitute the upper and major part of the plateau there are only 105 square miles of forest under the control of Government, the case of Manbhum which forms the lower part of the plateau is still worse as there are only 14 square miles of forests under Government control.

5. Effects of denudation.

(*a*) " Retrogression " of forest types.

It is a well-known fact that neither the soil nor the edaphic factors are constant and any change in the soil or edaphic factors beyond certain limits is followed by a change in the vegetation.

There may be "progression" or "retrogression," that is, the change may be from the lower to the higher type or from the higher to the lower type. There are many examples in Chhotanagpur to show both "progression" and "retrogression." These changes can be easily correlated with those in the soil which have been brought about by conservation or denudation of forests, as the case may be. This article is not meant to be a treatise on ecology, so I will content myself by quoting a few examples where "retrogression" has taken place in the wake of denudation.

In Chhotanagpur there is no doubt that sal forest is the true climax. This "formation" is found in many parts of the reserved forests of Singhbhum where it has been brought about by scientific forest management. Such management has been responsible for the establishment and growth of profuse regeneration which previous to the introduction of management was held in check by fires and intensive grazing. The Singhbhum forests, particularly the drier type of sal which constitutes the Saranda forest division, afford the best example of what proper management of a forest can achieve.

On the other hand, the study of forest vegetation on the plateau of Chhotanagpur and its neighbourhood shows most clearly that the forests which are not under Government management and where denudation is going on apace are undergoing deterioration and many of them have "retrogressed" to one of the lower types in the series of successive crops.

Sal is the chief tree in Chhotanagpur and the remains of previous extensive areas of sal forests are disappearing and are being replaced by more xerophytic species. Many of the village sites are, no doubt, clearings in old sal forests as is evidenced by the presence of sal groves in the villages. Many of these trees are of a large size, some being 6′-7′ in girth. They are left untouched on account of their being considered sacred when, as is often the case, there is a village shrine amongst them. Many of the hills surrounding cultivation are covered with miscellaneous scrub forest but scattered amongst it old sal trees in a mutilated condition are still to be seen. Old sal trees are even

seen growing from the crevices of rocks where all soil has been washed away. In places where erosion has taken place the sal forest is gradually giving place to a dry mixed forest. It must be remembered that the soil on the plateau is not very deep, but is quite suitable for sal. Its behaviour is different when the forest is destroyed. Not only does it erode away quickly but, as has been remarked before, it also becomes hard and unfit to support sal, but can and does support useless xerophytic species. The reason why sal has not disappeared altogether or is still found in some abundance in certain parts of the plateau is that it is so hardy. Many of the other species if they had been as maltreated as sal would have disappeared by this time. It was recorded in 1917 that "mutilated stumps are all that remain of the many valuable trees like *Dillenia aurea*, *Sterculia villosa*, *Soymida febrifuga* and *Ailanthus excelsa*, where only ten years ago there was considerable jungle." The conditions are much worse now. There is ample evidence to show from the study of the vegetation on the hills in the neighbourhood of those which are now bare that the latter were covered with jungle at no very distant date and the older inhabitants of many of the villages can give instances where hills have become more or less denuded within their lifetime. All the settlement reports and old historical records have a sad tale to tell of the terrible destruction of forests and this process is still going on even more actively than before. A journey along the Ranchi-Purulia road and through the Khunti sub-division of Ranchi would at once show an observer how the wooded hills alternate with those others which are quite bare of vegetation or covered only with scrub forest. There can be little doubt that they were once well-wooded.

(*b*) The economic effects of denudation are well-known but I would deal with only those which have become apparent in Chhotanagpur.

Chhotanagpur is almost entirely inhabited by the aboriginals except in towns and parts of Manbhum where a large number of foreigners have settled down. The forest requirements of an aboriginal are simple. He would be satisfied if he could get poles and small timber for his house, wood for his ploughs, carts and fuel. In many

parts both timber and fuel have become scarce and in some parts they are only available at a high price which an average aboriginal cannot afford to pay. He has therefore taken to burning of cow-dung and thus robs his land of the only manure he has at hand. The soil in Chhotanagpur is at its best poor and its continued cultivation for field crops without the addition of manure has greatly impoverished it. The yield has been reduced and many instances are known where fields have been abandoned for the labour involved in raising crops was quite out of proportion to the yield. Scarcity of fuel becomes evident when numbers of women and children are seen every morning in autumn and summer sweeping the roads of all the leaves which may have fallen overnight. These leaves are used as fuel.

In some places the fields are covered with sand brought through erosion, and ravines are being constantly formed where denudation has taken place.

Humus which was washed down the hills in the rains into the fields is no longer there to enrich the fields at the foot of the hills which have been denuded. Every villager knows this.

There is no stall feeding of agricultural cattle and there are no grazing reserves and the denuded stretches of waste land give practically no grazing. In the case of Manbhum, it is said that, "at the beginning of the cultivating season hundreds of plough bullocks are in too emaciated a condition to be able to do any kind of work and the *raiyat* must remain inactive until his cattle regain a little strength from new grass before they are fit for the plough." In many places good fodder grasses have been weakened and, in some places, they have been totally destroyed and replaced by inferior and unpalatable species.

Denudation has not affected the total annual rainfall to any appreciable extent, but there is no doubt that its distribution over the whole year has been considerably changed during the last 40 years or so. Cold and hot weather thunderstorms are not so frequent as they used to be. Scarcity of such thunderstorms has made it practically impossible to raise a *rabi* crop in Ranchi and Manbhum districts.

Ranchi was a well-known tea growing district, but the climatic conditions have been changed to such an extent during the last 30 or 40 years that infilling of tea bushes has become a most difficult, if not an impossible. task. Many observers say that denudation has created these adverse conditions.

The sources of the Koel and Karo. Subanareka and the Sankh have been either partially or completely denuded, the catchment area of the Damuda has also partly been laid bare. For this reason the rivers and streams of Chhotanagpur practically dry up in the hot weather; in the rains they come down in freshets rising rapidly in the course of a few hours and fall rapidly as soon as there is a break in the rains. This quick run off may not affect the people living on the plateau but those living below know to their cost the misery they have to go through periodically when these rivers are in flood.

The subsoil water level is very low in most places in Chhotanagpur. Wells are 40 to 50 feet and more deep and in many parts they dry up at the beginning of the hot weather. It can certainly be said that the conservation of the remaining forests will assist in preventing their level falling lower and a prevention of firing might possibly raise it locally. Even though the effect will be local it will still be of considerable importance.

Jungle produce plays a very large part in the economy of aboriginals. The quantity of edible roots and fruits available has been considerably reduced by the diminution of the area under forest and this must affect the people adversely in the time of scarcity. "In the famine of 1908, the people in the affected area lived mainly on jungle produce till the end of May and the distress was most severe in the rains when it was impossible to collect the produce. In Palamau, distress whenever it occurred always did so in the denuded areas, and forest tracts everywhere are considered immune, partly due to the scanty population, but principally because of the food-supply obtained from the jungle."

I cannot do better than quote Dr. Radhakumal Mukharji, PH.D., for explaining the evil effects of denudation. "Civilization however

primitive it may be, which was rocked in the cradle of the forests, which became mobile in the grass lands, and grew into its stature in the open plains and deltaic areas is now showing a reverse movement. As population multiplies, man encroaches upon grass lands and depletes them. His plough ascends the hill slopes and he destroys not only forests but also animals for the sake of agriculture and industry.

Man's one-sided exploitation thus upsets the balance of the region. Man's crime against grasses, trees and water does not go unpunished. The Mesopotamian and Indus civilizations came to grief because the careless hand of man destroyed trees so prodigally that the natural conditions of the country suffered disastrous reversions. Persia, Arabia, Syria and Egypt have also become dry and sometimes uninhabitable."

The above words coming as they do from one who is not a professional forester adds strength to our warning that denudation would spell havoc to the Indian community whose main occupation is agriculture.

6. *Causes of denudation.*

One of the causes of destruction of forests is ignorance and neglect of all principles of forestry. So far as the records show "the dominating ideas were the spread of agriculture, increase of population and the development of a country from the revenue point of view," not only the administrators but also the general public "appeared to regard with horror what is unfeelingly referred to as dismal waste of jungle, which is but one way of expressing the glorious harmony of forest covered hills with their wealth of natural animal and plant life." A study of Revenue and Forest Settlement reports will show with what minute attention the claims of the people have been considered, but unfortunately the officers charged with settlement work, for want of training in forestry, could not sufficiently appreciate the importance of forests and of the claims which the general public have on them. From time to time rules have been framed forbidding the felling of trees of certain species. This may mean that trees may

not be removed bodily, but as in the absence of proper management reproduction is impossible, the extinction of forest is merely a matter of time. Any interference with rights is at once greeted with the outcry that rights are being taken away. So sacred are the rights that they must not be curtailed in any way. The accepted legal principle that no right, or easement, can be exercised to such an extent as to endanger the existence of the property which it affects has seldom been taken into consideration in forest settlement reports.

Extension of cultivation is and has been the quickest way of destroying these forests. The land hunger seems to be so acute, not because it is insufficient but because of its poverty and consequent low productivity that even on the steepest slopes wherever there is a pocket of soil level enough to bear a crop, it is generally cleared and cultivated until the soil is washed off and the land is unfit for crops or forest.

Reckless and wasteful cutting by villagers and contractors is another cause of destruction. All the big trees have been removed some 30—40 years ago for preparing sleepers when the Bengal-Nagpur Railway extension took place. Such a clean sweep was made of all the sleeper yielding trees that there is now hardly a tree left in the forests not under the control of Government from which a sleeper could be made.

The villager will cut a huge tree in order that he may make a plough or a door. The rest of the tree is wasted. He will cut down any tree to get at honey secreted in its top. In many places whole hill sides have been denuded and burnt in order that the soil may be washed down on to a few poor fields below. Thousands of sal saplings are cut down by a single village every year to fence their fields. The wants of a village are few and could be supplied by a very moderate amount of forest; but the waste of uncontrolled cutting is sufficient to ruin the largest forests.

The settlement records show that in Chhotanagpur the forests do not belong exclusively either to the landlords or to tenants, both of these parties have been declared to have joint interest in the forests.

While the landlords have a right to sell the produce and they have exercised this right to the utmost limit; the tenants might remove forest produce for their own use only but not for sale. Actually it has been difficult to prevent the sale by tenants. Seeing that the tenants were abusing their rights, the proprietor himself helped in the destruction of the forests by selling the jungle outright or disposing of all wood and timber for which he could get a purchaser. There was therefore an insensate race between the landlord and the tenant and the forests suffered in consequence.

7. *Remedial measures.*

(*a*) Government propose for the present to take over all suitable forests in Ranchi district (which forms part of the catchment area of many of the local rivers) where the owners agree to lease them for 35 to 40 years, Government to pay the cost of management and a very small annual rent of one to two annas an acre, together with half the share of the profits.

This means that the owner will be certain of a small rental from the forests (in many cases the owners received no income from their forests in the past), that he will incur no expenditure, and that as the forests improved he will get something more in the form of a share in the profits. In the meantime, the forests will steadily improve in value, and at the end of 35 or 40 years, should be of considerable value.

Before the forests are taken over by Government they will be reserved under the Indian Forest Act and the interests of the *raiyats* will be secured by a forest settlement which will settle definitely what their rights are, and the forest department will see that these rights are secured to them and nothing beyond their rights given. Government will have to pay out more than Rs. 40,000/- a year during the early years. It is hoped that the forests will gradually improve and that the income from them will gradually become greater and it is possible that towards the end of the lease, Government's half share in the profits may recoup them for their early expenditure. But the actual profit is not likely to be very great, and Government will rely for a return for their expenditure, not on any actual money that may come in but on the fact that the forests have been preserved, that

they have been turned into valuable property and that the owner when he gets them back, if he is wise, must see that the only way of getting an income from them is to continue proper management.

A rough estimate may be given of the area of private forests which could be reserved or protected in the plateau area if the scheme outlined above is acceptable to private owners.

The area of forest given in settlement reports does not give any idea as to whether the whole of it or only part of it, and if the latter how much of it is suitable or available for reservation. The area of forest given in the settlement reports is enormous. It includes :— (*a*) Forest which is commonly known as culturable forest. It is often situated on the upper parts of hills with sufficient soil and is brought under the plough sooner or later. The quick return in the form of land rent is too great a temptation for an average landlord to retain this as forest, (*b*) grass lands and marsh lands, (*c*) small patches of forests scattered all over the area and (*d*) bare hills and as a matter of fact anything which is inaccessible and unfit for cultivation. After deducting the area covered by these items, which is sometimes more than 75 per cent. of the total area shown as forest in settlement reports the area left over which may be suitable for scientific management, is very small indeed. It is difficult to estimate this area without a detailed examination of the locality but general observation shows it to be about 400 square miles on the plateau as a whole in addition to about 100 square miles of reserved forests in Hazaribagh district belonging to Ramgarh Estate at present under the Court of Wards.

(*b*) *Propaganda.*—" Owing to the extreme ignorance of the aims and policy of the Forest Department and the value of the forests to the province as a whole, propaganda is one of the most important remedial measures." In these democratic days, " no scheme, however attractive or beneficial it may be, will have much chance of success unless we can get public opinion to support it." Necessary steps have been or are being taken to attain this object by organizing lectures and distributing leaflets by the Forest Department and by a newly formed Bihar and Orissa Forest Association consisting of landlords and *raiyats* and other people interested in forestry.

A SURVEY OF INSECT DAMAGE TO INDIAN TIMBERS IN LONDON.

BY F. R. CANN.

(*Forest Products Research Laboratory. Princes Risborough.*)

I.—INTRODUCTORY.

In 1931 some skirting boards of white chuglam (*Terminalia bialata*) in the recently completed India House, London, were found to be attacked by a wood-boring insect. The wood was examined by Professor J. W. Munro of the Imperial College of Science and Technology, who reported to the Indian Timber Adviser that the damage was caused by *Lyctus* Powder-post beetles. At first it was suspected that the insects were *Lyctus africanus*, which occur commonly in most tropical parts of the world, but subsequent examination by M. Lesne of the Museum d'Histoire Naturelle, Paris, showed them to be *Lyctus brunneus*, a cosmopolitan species already common in Great Britain. In his report, Professor Munro drew attention to the importance of this occurrence of *Lyctus* in Indian timbers, emphasising the need for an inspection of docks and yards in this country to ascertain not only the extent of *Lyctus* damage in these timbers but also whether tropical species such as *L. africanus*, which is common in Northern India, were being introduced into Great Britain. He also pointed out the significance of the matter from the point of view of the marketing of Indian timbers in this country.

As a result of this occurrence and of a further instance of *Lyctus* damage in white chuglam about the same time, it was arranged at the request of the Indian Timber Adviser for the Forest Products Research Laboratory to carry out an investigation into the losses caused by *Lyctus* and other wood-boring insects in Indian timbers in this country, linking up this work with similar investigations being undertaken by Dr. C. F. C. Beeson, at the Forest Research Institute, Dehra Dun. The work in this country was carried out in the summers of 1932 and 1933 and formed an extension of the survey already undertaken by the Forest Products Research Laboratory in 1929 and 1930, an account of which has been published. (3).

Timber was inspected at the West India Docks, London, and on the premises of a number of firms in London. Comparatively few firms hold large stocks of Indian timbers outside the London area and it was not considered necessary to extend the survey to provincial centres. During visits to the premises of importers, notes were taken of the species of Indian woods in stock and the approximate quantities on hand at the time of inspection. When damage by Powder-post beetles was discovered, particulars were taken of the size of the timber, the length of time it had been in the yard and the date of arrival in this country. Notes were also made of damage by Pin-hole borers, Longhorn beetles, and other wood-boring insects.

II.—INSECTS CONCERNED.

1. *Lyctid and Bostrychid Powder-post Beetles.*

(*a*) *Lyctidae.*

Beeson (2) states that the Lyctids known to occur in India are: *Lyctus africanus, L. spinifrons, L. brunneus, Lyctoxylon japonum, Minthea rugicollis,* and *Trogoxylon suriculatum.* During the present survey in this country, the only Lyctids found in Indian timbers were *L. brunneus* (in white chuglam and laurel) and *Minthea rugicollis* (in white bombway). Beeson mentions *L. brunneus* as occurring in white chuglam but he gives no record of this species in laurel nor does he give an instance of *Minthea rugicollis* in white bombway. *Lyctus brunneus* is cosmopolitan in distribution and is the commonest species now occurring in Great Britain, but on each occasion that it was found the condition of the timber indicated that infection had taken place before the parcel arrived in this country, with the exception of one doubtful case. In addition to the record of *Lyctus* in white chuglam, several other instances have occurred of similar damage in samples of this timber sent to the Laboratory.

No record was obtained of *L. africanus*, the most abundant species in Northern India, but this may be because the majority of the timbers examined, with the exception of laurel, came from the Andaman islands where *L. africanus* does not occur.

(*b*) *Bostrychidae.*

According to Beeson, the following Bostrychidae are the most injurious in India—

Sinoxylon anale.
S. crassum.
S. sudanicum.
Heterobostrychus aequalis.
Schistoceros anobioides.

During the present survey, *Sinoxylon anale* and *S. crassum*, were found boring in the sapwood of laurel logs, two separate consignments being attacked. The smaller species, *S. anale*, was still active in the logs but only a single specimen of *S. crassum* was taken, though a considerable number of exit holes made by this species were noticed. The presence of *S. anale* in laurel caused considerable alarm to the agents for this timber, who feared that the damage would decrease the market value of the logs. As far as could be ascertained, however, the damage was confined entirely to the sapwood.

An unusual and interesting case of Bostrychid damage to teak arose at the beginning of 1933. Several separate consignments of this timber were found on arrival in this country to be superficially tunnelled by insects. Three parcels of gurjun arrived in a similar condition and samples of the damaged wood were sent for examination to the Natural History Museum, London, and to the Forest Products Research Laboratory. The two reports agreed that the damage had been caused by the Bostrychid beetle, *Dinoderus pilifrons* (the Bamboo Shot-hole Borer), dead beetles of this species being found in the tunnels. The beetles had not attempted to breed in the teak and gurjun, but, as was subsequently found, had migrated from infested bamboo dunnage on board ship. Samples of the damaged teak were returned to India and examined by Mr. D. J. Atkinson, Deputy Conservator of Forests, Burma, who reported on the occurrence (1).

2. *Other Wood-boring Insects.*

Damage by Pin-hole borers (beetles belonging to the families Scolytidae and Platypodidae) was noticed in Indian timbers during visits to docks and timber yards.

No living insects were found on any occasion. Except for some logs of East Indian satinwood, a small parcel of haldu and a few discarded boards of Indian silver greywood, no severe damage was seen during the survey.

Damage caused by the larvæ of Longhorn beetles (family Cerambycidae) is often difficult, if not impossible, to distinguish from that of wood-boring caterpillars (order Lepidoptera). Few defects of this type were noticed except for a little damage in teak. A large quantity of this timber, sawn to various sizes, was inspected during the survey, though it was invariably close-piled, making a detailed inspection difficult. Most of it appeared singularly free from insect defects but a few boards were noticed to be slightly damaged by Longhorn larvæ and by the caterpillar of the wood-boring moth, *Xyleutes* (*Duomitus*) *ceramicus* (the Bee-hole borer of teak).

III.—ATTITUDE OF IMPORTERS AND BROKERS.

Most of the importers of Indian timbers visited during the survey hold large stocks of Home-grown and foreign hardwoods and are well acquainted with the different types of insect damage, particularly that caused by *Lyctus* Powder-post beetles, in such timbers as oak, ash and walnut. *Lyctus* infection in these woods is a common occurrence and, in the eyes of importers, rather eclipses the comparatively few instances of attack which they occasionally notice in their smaller stocks of Indian timbers. Nevertheless, concern was expressed lest damage should become more widespread in the latter. The attitude of brokers in London dealing with Indian timbers was more definite on the subject and is adequately expressed in the following extract from a letter which was received from a firm :—

......" We think that the investigations which you are carry-
" ing out concerning insect damage in Indian timbers are of the
" highest importance, because the very fact that any particular
" wood is likely to come forward in a wormy condition, although
" only occasionally, is naturally a very severe handicap indeed in
" our efforts to develop business in Indian and Andaman timbers."

In one instance, a squared log of white bombway 23 × $1\frac{1}{4}$ × $1\frac{1}{4}$ feet was discarded as useless on account of Lyctid and Bostrychid damage in the sapwood, the brokers preferring to sacrifice the entire log rather than go to the expense of removing the sapwood, which alone was infested, and selling the remainder.

IV.—Summary.

The following table summarises the records of insect damage obtained during the survey :—

Timber.	Approx. total quantity inspected.	Approximate quantity found damaged by insects.			Percentage showing insect defects.
		Lyctidae and Bostrychidae.	Pin-hole.	Longhorn Lepidoptera.	
White Chuglam (*Terminalia bialata*).	15,000 cu. ft.	10 cu. ft.	..	..	0·06%
Indian Silver Greywood (*Terminalia bialata*).	8,000 cu. ft.	..	30 cu. ft.	..	0·4%
Laurel (*T. tomentosa*)	136 logs.	42 logs.	9 logs.	..	37%
White Bombway (*T. procera*)	1,000 cu. ft.	35 cu. ft.	..	..	3·5%
Indian White Mahogany (*Canarium euphyllum*).	2,300 cu. ft.	..	A few boards.	..	A few boards.
Rosewood (*Dalbergia latifolia*)	(*a*) 10 logs	..	A few boards.	A few boards.	A few boards.
	(*b*) 500 cu. ft. (boards)	..	..	..	..
Padauk (*Pterocarpus dalbergioides*)	28 logs.	..	..	A few boards.	A few boards.
Haldu (*Adina cordifolia*).	270 cu. ft.	..	35 cu. ft.	..	1·2%
Gurjun (*Dipterocarpus alatus*).	Several hundred thousand cu. ft.	Three instances of superficial damage by *Dinoderus pilifrons*.	Slight damage in a few pieces.	..	Slight damage.

Timber.	Approx. total quantity inspected.	Approximate quantity found damaged by insects.			Percentage showing insect defects.
		Lyctidae and Bostrychidae.	Pin-hole.	Longhorn Lepidoptera.	
Teak (*Tectona grandis*)	Several hundred thousand cu. ft.	Three instances of superficial damage by *Dinoderus pilifrons*.	Slight damage in a few pieces.	Damage by Marine borers in old pieces. Also tunnelsmade by *Xyleutes* (*Duomitus*) *ceramicus* (Bee-hole borer).	A few pieces.
East Indian Satin-wood	(*a*) 40 logs	..	30 logs	..	75%
(*Chloroxylon swietenia*)	(*b*) 500 cu. ft. boards.	..	..	..	..
Palu (*Mimusops hexandra*).	2 logs	..	..	..	Nil.
Eng .. (*Dipterocarpus tuberculatus*).	150 cu. ft.	..	..	..	Nil.
Pyinma .. (*Lagerstroemia hypoleuca*).	1,500 cu. ft.	..	..	..	Nil.
Kokko .. (*Albizzia lebbek*).	1,000 cu. ft.	..	..	..	Nil.

The most important type of insect damage in Indian timbers entering this country is, from an economic standpoint, that caused by the Lyctidae and Bostrychidae. From the figures given in the preceding table the percentage of damage of this type is small and might at first appear negligible. It should be realised, however, that the records of damage included in this report have been obtained as the result of only one, or at the most, two, visits to docks and importers' yards. Moreover, most of the timber inspected, that is liable to attack by these insects was in the form of boards and planks and it was not normally possible to examine the bulk of a pile but merely the outside boards; only a minimum estimate, therefore, could be obtained of the

amount of infection present in the whole parcel. On the other hand, logs could be examined in greater detail, and quite a large percentage of the laurel was found containing Lyctid and Bostrychid damage.

No severe cases of Pin-hole borer attack were noticed ; the most concentrated damage was found in East Indian satinwood, where the extent of the tunnels could not be ascertained as the timber was in the form of unsawn logs. Damage in isolated boards of teak and gurjun was recorded but these timbers were stacked in quantities too large to examine in detail.

Few occurrences of Longhorn and Lepidopterus damage were recorded and this type of defect was the least important.

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THE ROLE OF UNDERGROWTH IN THE SPREAD OF THE SPIKE DISEASE OF SANDAL.

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Spread of the Disease.—Though the disease was first officially noticed in Coorg in 1899 by McCarthy, the forest officers both in Mysore and Madras had not realised the existence of the disease till 1903, when it was found that the disease was widely distributed in many of the important sandal areas in the south-western portion of the Mysore State, and also in North Coimbatore. In the latter Lushington (5) observed a variety of sandal with small pale leaves in 1895 and hundreds of trees dying in 1898 and spike was definitely recognised by him in the locality in 1903. It is obvious that in Coorg, Mysore and in North Coimbatore, the disease must have existed for

several years before it was recognised. The data regarding the spread of the disease in Mysore and Madras in the next few years is not quite accurate, as in many cases the disease was apparently reported long after it actually appeared. Under these circumstances it is not possible to locate any primary seat of infection.

Coleman in his bulletin on spike disease published a map noting all the areas in Southern India spiked till the year 1916. The northern limit to which the disease had then spread could be roughly demarcated by a line drawn due east to Bangalore from the northern corner of Coorg.

In the Mysore State there are two distinct belts of sandal zone, the larger in the western and the smaller in the eastern half of the State. In the western belt the disease has scarcely made any headway in a northerly direction. In 1904-05 the northern limit to which the disease had spread in this zone was Konanur Hobli in Arkalgood Taluk, where an area of two square miles near the Coorg frontier was reported as affected, and during the next 26 years, the disease has travelled only five to six miles in a northerly direction.

In this locality though there are well-stocked uninfected sandal areas the skipping of the disease even over a few miles was conspicuously absent till a couple of years back when it showed a sudden spurt of activity and crossed over a distance of five miles, affecting Vijapur forest. Towards north of Arkalgood, the annual rainfall increases and it has not yet been established if this factor retards the spread of the disease. McCarthy (6) opines that the infection and spread of spike is less active in zones of heavy rainfall. In the drier eastern belt the disease has travelled more rapidly in a northerly direction than in the western belt. Between 1916 and 1932, it has spread nearly 40 miles in a northerly direction towards Tumkur.

In discussing the rate of spread of the disease in different directions, it is very misleading to consider the spread in individual areas. If the general spread of the disease in the whole sandal zone in Southern India is taken into consideration, differences in the direction of spread are clearly discernible. The disease has travelled most

rapidly towards the south and south-east often skipping over enormous distances. Rama Rao (8) records that when infection appeared in Kollimalais, the nearest known spiked area was 80 miles away. Even as early as 1916 the disease had practically touched the southernmost limits of the sandal zone in South India. The spread has been less rapid in a north-easterly direction, while its progress towards the north has been the poorest, and skipping over long distances conspicuously rare. It is not generally known that the northern half of Mysore State, containing some of the richest sandal areas, and the adjacent sandal tracts in Dharwar, Canara and North-Coorg are still entirely free from the disease, and there has been no endemic attacks of spike, unlike the sandal areas of Madras Presidency.

Classification of sandal areas.—The bulk of the sandal in Southern India is found in open scrub jungles with a rainfall of 25 to 40 inches. It is sparsely distributed in pole forests, but is rarely seen in high forests. In Malnad areas of Mysore its distribution is irregular and extends to the semi-evergreen belt with a rainfall up to 200 inches. It is also found extensively in cultivated lands, private holdings and village sites, especially those found in or adjoining the two belts of sandal in Mysore noted already, and the yield of wood from these areas fall next in value to that from scrub jungles.

The incidence of spike disease in the different types of sandal areas noted above shows considerable differences. Leaving aside the Malnad areas in the northern portion of the State to which the disease has not yet spread, the sandal areas may be grouped into the following classes in order of decreasing severity in the incidence of disease :—

(1) Dry scrub jungles with a more or less dense stock of sandal.
(2) Pole forests with sporadic or sparse growth of sandal.
(3) Cultivated lands, assessed waste, private holdings and village sites, with a varying density of sandal stock.

Scrub Jungles.—The disease is most severe in scrub jungles, and in many cases the entire stock of sandal has been wiped out in periods varying from 6 to 20 years. These jungles are generally heavily worked for fuel, and sandal often forms the dominant species. There

is invariably a more or less heavy undergrowth of thorny bushes and climbers. After the original stock of sandal is killed by the disease, natural regeneration often comes up profusely under bushes, but the saplings get spiked after their crowns overtop the bushes. In the experimental plots under observation it has been found that 20 to 25 per cent. of the saplings which have overtopped the bushes get spiked every year, which means that the saplings rarely survive more than four to five years after emerging from the bushes.

Pole Forests.—Pole forests contain fairly large trees many of which grow to bigger dimensions than sandal. The latter is therefore often overtopped and partly shaded by the associate species. Sandal is sparsely found in these forests. They are sometimes found in isolated patches or single trees are found at long intervals. The spread of the disease is very slow in these forests and there are areas in which the disease appeared 30 years ago and which still contain many scattered healthy sandal. The undergrowth is often nearly of the same composition as in scrub jungles but of lesser density.

Assessed Lands.—Under assessed lands are included all cultivated lands, private holdings, assessed waste and village sites.

These areas often contain large numbers of sandal trees, distributed mostly along hedges round cultivated plots and holdings. The incidence of disease among them is extraordinarily low, and diseased trees are only met with at long intervals. The loss of trees from the disease in these lands is unappreciable as compared to that in scrub jungles. Even in our oldest and heavily spiked areas large and healthy sandal trees are met with in private holdings, within a couple of furlongs from scrub jungles where the entire stock of sandal was wiped out many years ago.

Statistical data regarding the incidence of disease in jungles and assessed lands.—It has not yet been realised that the ecological conditions in assessed lands provide a high degree of immunity from the disease to the stock of sandal trees growing in such lands. This factor is prominently seen if the stock of sandal in spiked and unspiked areas is compared. For this comparison Hunsur and Shikarpur Taluks,

two of our richest sandal areas, are selected as they are nearly similar to each other in point of climate, distribution of sandal in jungles and assessed lands, rate of growth and sandal associates. Hunsur Taluk is an old spiked area in Mysore District and Shikarpur Taluk lies in the northern half of the State which is entirely free from the spike disease. The stock of sandal in both the taluks has been fully enumerated and working plans prepared.

The following gives details of the healthy stock of sandal in jungles and assessed lands in the two taluks :—

Name of Taluk.	Area in sq. miles.	Growing stock of sandal in girth classes.				
		9″—18″	18″—27″	27″—36″	36″—45″	over 45″
(a) Assessed lands—						
Hunsur ..	354	45,103	19,039	5,465	1,023	281
Shikarpur ..	281	42,930	17,504	3,935	691	63
(b) Jungles—						
Hunsur ..	319	71,026	9,541	2,112	301	73
Shikarpur ..	242	4,02,568	1,09,084	20,148	2,713	269

The above figures worked out per square mile give a clearer idea for comparison as noted below :—

Name of Taluk.	Stock of sandal in girth classes per sq. mile.			
	9″—18″	18″—27″	27″—36″	36″—45″
(a) Assessed lands—				
Hunsur (spiked)	127	54	15	3
Shikarpur (healthy)	153	62	14	2·5
(b) Jungles.				
Hunsur (spiked)	223	30	6	1
Shikarpur (healthy)	1,663	450	83	11

From the above it can be seen that while there is very little difference as regards the stock of sandal in assessed lands in the two taluks, the stock in Hunsur jungles is only one-eighth to one-fifteenth in the different girth classes, when compared to the unspiked areas in Shikarpur. Before the advent of spike, Hunsur was considered richer in sandal than other areas in Mysore and now at least 90 per cent. of the stock has disappeared from the jungles, while the disease has scarcely caused any appreciable damage in the stock of sandal in assessed lands. The latter in fact contains more sandal trees in all girth classes except 9″—18″ than in jungle lands.

The average yield of sandalwood in Hunsur Taluk before the advent of spike disease was approximately 100 tons, but the present outturn is only 1/5th of this figure and the bulk of it is derived from assessed lands.

Difference in ecological factors between scrub and assessed lands.—The striking difference in the incidence of the disease between scrub jungles and assessed lands is apparently due to the ecological conditions in the two areas. Sandal being a royal tree in Mysore is the property of Government wherever found. Whenever any scrub is given out for cultivation, while all other growth is uprooted, any stock of sandal found is left intact and hence several sandal trees are found dotted over cultivated lands. In addition trees are also found along hedge-rows round cultivated plots, in which natural regeneration comes up. Assessed lands differ from scrub jungles in the following important respects :—

(1) Cultivation of the soil.

(2) Density of sandal stock.

(3) Absence or paucity of undergrowth and associate species.

Cultivation of soils.—Ploughing the soil and raising of field crops in private holdings doubtless provide good soil aeration and healthy environmental conditions to sandal trees in the locality. But this factor cannot account for the low incidence of the disease, as in other uncultivated holdings, such as village sites and assessed waste lands in which the undergrowth is absent, the incidence of the disease is equally low.

Density of sandal stock.—The stock of sandal trees is generally more scattered in assessed lands than in scrub jungles. As a general rule the disease spreads more rapidly in areas heavily stocked with sandal than in those in which it is thinly scattered. But this factor may be taken to account for only a small extent of the difference in the incidence of the disease between the two types. This can be clearly seen when the very high incidence of the disease in jungles is compared with that in adjacent cultivated lands in which the stock of sandal per acre is approximately the same.

Undergrowth and associate species.—Undergrowth is suspected to be a dominant factor in the spread of the disease. In scrub jungles generally the thicker the undergrowth the more severe is the incidence of the disease. In some of the sample plots under observation with a heavy undergrowth, all the stock of sandal has been wiped out in four to six years after the disease appeared in the area, while in others where the undergrowth is thin only 40 to 50 per cent. of sandal trees were affected in a similar period. In lands under cultivation, obviously the undergrowth is either entirely absent or confined to thin lines in the form of a live fence, which may account for the low incidence of the disease among sandal growing on such lands. But in private holdings, or abandoned old cultivated lands, where rank vegetation is allowed to cover up the ground, the incidence of disease is as severe as in scrub jungles.

Even in scrub jungles the difference in the incidence of the disease caused by the undergrowth can be seen clearly on demarcation lines which separate the reserves from the village jungles. These demarcation lines in Mysore are 66 feet wide and are kept clear of undergrowth. The sandal trees standing on these cleared lines generally escape infection for a much longer time than those inside the jungles on either side. In one case the writer observed a demarcation line acting as a temporary check to the spread of the disease; while on one side several sandal trees were newly spiked all along the demarcation line, only one tree on the other side of the line had caught the infection. Sreenivasiya and Rangaswami (10) advance the following theories regarding difference in the incidence of disease in different areas :—

(1) Diseased areas are characterised by a complete absence or diminished occurrence of certain types of hosts which are considered to impart qualities of resistance to sandal, (2) Severity of disease in scrub jungles is due to over-exploitation of associate species as indicated by a high percentage of coppiced and dead stumps, and (3) the consequent change of the host plants from deep rooted trees to surface feeding bushes like lantana. If any of these theories hold good, then the disease among sandal in cultivated lands and holdings must be far more severe than in wooded lands, as in the former, host plants of sandal are either absent or such of them as are found in small numbers along hedge-rows are much more severely hacked down than in lands under Government control. In this connection it may also be pointed out that root system of sandal is very superficial and is generally confined to a depth of soil within two to three feet of the surface.

COMPOSITION OF THE UNDERGROWTH IN SCRUB JUNGLES.

Leaving aside the species found in small numbers the main undergrowth in the scrub jungles of Mysore consists of the following :—

(1) *Lantana.*
(2) *Dodonaea viscosa.*
(3) *Acacia pennata.*
(4) *Pterolobium indicum.*
(5) *Gymnosporia montana.*
(6) *Jasminum sessiliflorum.*

In the above list two climbers are included among undergrowth, as in the absence of trees for support they often assume a bushy habit. In some jungles all the above species are found, while in others there is a mixture of at least three or more of them.

It has not been possible so far to single out any of the above as responsible for the spread of the disease. Lantana has often been suspected as being responsible for the spread of infection, but this theory cannot be substantiated, as the disease spreads equally rapidly in areas where the undergrowth contains little or no lantana. In 1917 McCarthy (6) stated that "In Kollegal and North Coimbatore, there are a dozen isolated sandal areas extending to thousands of

acres in which new infections of the disease have occurred and in which the whole of the sandal has been swept away, where not a single lantana plant existed." In 1905 Muthanna (7) wrote that in Chamrajanagar and several other infected localities, no lantana was found for miles round the affected tracts. The writer has also come across similar areas and it is obvious that undergrowth other than lantana is equally conducive to the spread of the disease.

It has now to be discussed how the undergrowth can help in the spread of infection. In the light of our present knowledge of the disease the following possibilities suggest themselves :—

(1) Communicability of spike-like disease among undergrowth and associate species to sandal.

(2) Possibility of the undergrowth acting as carriers of the disease without themselves being affected.

(3) Undergrowth turnishing harbourage for insect vectors.

(1) Spike-like disease among plants other than sandal :—

In sandal areas some of the associate species are affected by a spike-like infectious disease. The most prominent among them are *Zizyphus oenoplia, Dodonaea viscosa, Strachytarpheta indica* and *Vinca rosea*. Infected plants of all the above species have been grown with healthy sandal in pot-cultures, and though sandal haustoria fed on their roots, the disease could not be transmitted to sandal. It is now well-known that spike disease in sandal can be transmitted through haustorial connections (3).

(2) Undergrowth as carriers of disease :—

"Carriers" is the designation applied to plants which are systematically infected with a virus, but which are not visibly affected. In a few virus diseases, the existence of carriers has been ascertained. With a view to find out if any plants in the undergrowth in spiked areas act as carriers, all the species commonly found in sandal areas were uprooted in a heavily infected area and transferred to pot-cultures with healthy sandal plants. These plants have been under observation for the past one year, and though the results obtained have been negative so far, they are considered still inconclusive.

(3) *Undergrowth acting as harbourage for insect vectors.*

Several workers who have investigated the disease strongly suspect the existence of insect vectors. Additional support is lent to this view by the fact that the infection also travels above ground which has been proved in a later part of this paper. Dover (4) appears to have succeeded in transmitting the spike disease through a Jassid, *Moonia albimaculata* fed on spiked sandal, but there has been some controversy about the validity of the results obtained, and the experiment has to be repeated and results verified.

Dense undergrowth doubtless affords a suitable habitat for the insect world to thrive and multiply, and if the insect transmission of the disease is definitely established, it will clarify the rôle of undergrowth in the spread of the disease. In a previous paper (13) on variation of results under different methods of inoculation, it has been shown that a minimum dose of infective material is apparently necessary to produce the disease. Similarly there may be a minimum dose in the case of insect transmissions, and a large number of vectors or repeated infections may be necessary, and the undergrowth when thick and extensive may provide the most favourable conditions for insect transmission of the disease.

THE INCIDENCE OF DISEASE AMONG ARTIFICIALLY RAISED STOCK.

To study the incidence of the disease among artificially raised sandal, under natural conditions, the following experiments were conducted in a sample plot of one acre laid out and fenced with wire in the infected scrub jungle of Mannugudde in Bangalore District. The soil is gravelly and the rainfall 25 to 28 inches. The undergrowth is dense, consisting mainly of *Lantana*, *Acacia pennata*, *Pterolobium indicum*, *Jasminum sessiliflorum* and *Dodonaea viscosa*. When the plot was laid out there were 21 sandal trees in it out of which 10 were spiked and the remainder got spiked in two years. Only Rosette type of the disease (12) was found in the locality.

EXPERIMENT No. I.

Trenches one foot deep and one foot wide were dug in lines 15 to 20 feet apart and the undergrowth between the lines was left undisturbed,

Sandal seedlings two months old raised from seeds of a single tree in Shimoga which is in the spike free northern half of the State were planted along with seedlings of 17 different hosts on mounds beside trenches in May and June 1928. The plants were watered during the first year. The condition of plants at the end of every year is noted below. All sandal saplings were kept free from encroachment of the adjacent undergrowth.

1929. At the end of June 1929 out of 629 sandal plants put out 259 survived and they were two to three feet high and none were spiked. Among host plants the survivals were 115 out of 517.

1930. At the end of June 1930, 90 sandal plants survived and appeared well established. They were four to six feet high and all quite healthy. Among host plants put out the survivals were only 10 per cent.

1931. Between 1930 and 1931 large numbers of sandal plants were destroyed by the coffee *Zeuzera coffeae* and only 53 sandal saplings four feet to seven feet high survived. Three saplings died back and sent out stool shoots. The first appearance of spike among these saplings was noticed early in April 1931 that is nearly two years and nine months after the sandal seedlings were planted out. By end of June 1931 eight saplings were spiked. Sandal saplings start flowering during or after the third year and in the experiment 23 saplings out of 51 survivals had flowered at the end of three years. But of the above eight spiked saplings, six had not flowered at all.

1932. During the year ending June 1932, twenty more plants got infected.

1933. Thirteen previously healthy sandal developed spike and three others died without showing any visible signs of the disease.

1934. Out of the remaining 12 plants nine developed spike—two died without showing any signs of the disease and only one plant survived healthy by the end of June 1934. The surviving plant is a stool shoot of one of the three saplings that died back in 1931.

EXPERIMENT No. II.

In the same sample plot sandal seeds from the same tree, which was used in raising the stock in the first experiment, were dibbled in June 1928 under 40 different bushes adjacent to the trenches dug for the first experiment to ascertain the difference in the incidence of the disease between plants grown in open and under bushes. Eight seeds were used under each bush. The seeds or plants were not watered. Owing to damage by rodents only 64 seeds germinated under 22 bushes, and by the end of June 1931 only 23 plants under 16 bushes survived, but the saplings were well established and were three feet to six feet in height, and half the number of plants had emerged out of the bushes in which they were growing. The spike disease appeared among them at the same time as in experiment I, and one plant was spiked in April 1931 and two more in May and June of the same year. During the next three years the numbers of plants which developed spike were three, seven and five respectively. But none of them got the disease till they emerged out of the bushes. One plant died in 1933 without showing any signs of the disease. By the end of June 1934, only four out of 23 plants still remained healthy, of which three had not yet overtopped the bushes in which they were growing.

EXPERIMENT No. III.

Experiments Nos. III and IV were started in the sample plot in 1932. Between 1928 and 1932 when the first and second set of experiments were started respectively, there was a conspicuous change in some of the environmental factors in the locality which has to be noted. Continued protection of the plot from fire and cattle resulted in an increased density of the undergrowth, and natural regeneration of sandal which was scanty in 1928 had become very profuse in 1932. In the latter year there were 135 naturally grown sandal saplings above three feet in height in this sample plot of one acre out of which 61 were spiked. In addition there were 34 spiked saplings raised in experiments I and II. The area had thus become a hot bed of the spike disease when the two second set of experiments were started.

For the third experiment, without disturbing the undergrowth 30 small blanks found in the area were converted into seed beds, and seeds collected from 30 different trees under observation were sown in December 1932 and watered. The experiment was undertaken to test under natural conditions the stock raised from certain parents which are standing healthy in spiked areas which were suspected to be resistant to the disease, and from parents pertaining to different sandal varieties (11). The germination was nearly complete by the end of April 1933. The disease first appeared among the seedlings in the beginning of February 1934, that is, when the plants were only nine to 10 months old, against two years and nine months in the first experiment. At this time there were over 800 plants in the beds and they were from a few inches to three and a half feet high, and all the plants were growing exposed free from bushes. The disease first appeared in two plants in one bed, and in one plant in each of four other beds. The height of these plants varied from one foot three inches to two and a half feet. Such young plants as one foot three inches naturally growing under bushes have never been found spiked by the writer in the various spiked areas inspected by him during the past six years. By the end of June 1934, there were altogether 16 spiked plants in nine different beds. The experiment is still incomplete and may yield some more interesting results in the near future regarding the susceptibility of plants in other beds.

EXPERIMENT No. IV.

Twenty potted sandal plants one to two years old, grown in a spike free area, were transferred to the sample plot at the end of June 1932. The pots were distributed all over the plot and were placed on stone slabs on the mounds used in the first experiment, free from the adjacent bushes.

This experiment was undertaken in co-ordination with Mr. V. Subramanyam, officiating Entomologist in the Department of Agriculture in Mysore, with a view to ascertain if the disease travels above ground. The disease first appeared among the potted plants at the same time as in experiment III, that is, at the beginning of February

1934, and one year and seven months after the potted plants were placed in the area. Only three plants were spiked in February 1934 and two more developed the infection in May 1934.

Some aspects of the disease revealed by the above experiments.

(1) *Incubation period.*—In the first two experiments it took two years and nine months for the healthy stock introduced in the spiked area to get the disease. In the third and fourth experiments the period was nine months and one year seven months respectively. The shorter period in the latter set of experiments may be due to the plot having become more infectious and to some of the stock used being more susceptible to the disease than those raised from a single parent in the first two experiments.

The shortest incubation in nature is obviously less than nine months as it is not known when the plants in experiment III caught the infection. It may even be the same as in artificial inoculations which in a previous paper (13) has been noted to be three months.

(2) *Transmission of the disease above ground.*—In experiment IV, it has definitely been proved that the disease travels above ground. Coleman (3) has shown that the disease can travel below the ground through haustorial connections, which can only account for the spread of the disease among neighbouring plants. How the aerial infection takes place is still a matter of conjecture. As already stated insect vectors are strongly suspected. In this connection it is interesting to note the entire absence of aerial infection among pot-cultures. In the office compound of the Director of Agriculture in Mysore, where the writer has been conducting pot-cultures experiments during the past six years there have been always several inoculated and spiked potted sandal, scattered among nearly a thousand other pots containing healthy stock, but there has not been even a single case of natural infection among the lot. But among potted plants placed in the sample plot in experiment IV, 25 per cent. got spiked after one year and seven months. Of course where the pot-culture experiments are being carried out in the office compound, the area has always been kept clear of all weeds and rank vegetation and this factor probably accounts for the absence of natural infection.

(3) *Absence of disease among young stock under bushes.*—McCarthy (6) was the first observer to notice that "young plants coming up under dense lantana sufficient to protect their crowns from aerial infection were invariably immune from attacks whereas all round them plants which had just broken out of the lantana were attacked." Subsequent investigators have confirmed this observation and young stock whether covered by lantana or other bushes are invariably found apparently healthy. For instance in the sample plot where the experiments were conducted, it was noted that there were 135 naturally grown sandal saplings in bushes above three feet, out of which 61 were spiked, all of which had overtopped the bushes. But under the bushes there were over 200 plants below three feet in height and none of them were spiked. In experiment II where seeds were dibbled under bushes no plant got spiked till they overtopped the bushes, and out of the four still remaining healthy after six years, the crowns of three saplings are still inside the bushes while one has just grown above them.

The following theories have been advanced to account for this phenomenon:—

(*a*) That young stock is immune to the disease. In nature all natural regenerations are found under bushes and it is extremely rare to find any in the open to compare the incidence of the disease between them. Experiment III proves that young stock nine months old and only one foot three inches in height are as susceptible to the disease as older plants and this has also been proved by artificial inoculations.

(*b*) That sandal saplings should at least flower once before they can catch the disease. Sandal plants start flowering in the third and fourth years and in all the four experiments noted, flowering of the plants has been no criterion for the development of the disease. It is well-known that partially spiked trees produce both flowers and fruit in branches that are apparently healthy, and spiked and apparently healthy flowering twigs are often found on the same branch. Numerous attempts were made by the writer both in pot-culture

experiments and in the field to transfer infection through pollen, but all gave negative results. To ascertain if any seed from partially infected trees carried infection, seeds from several such trees were sown in nurseries and in pot-cultures but the stock always grew healthy and there are on hand several healthy plants that are six years old.

Discussion.—In Experiment III it has been clearly shown that very young plants only nine months old and a little over a foot in height growing in the open just outside the bushes get spiked, whereas much older stock inside the bushes remain healthy till they overtop the bushes, though all other ecological conditions remain the same. In a previous paper (13) it has been shown that young saplings can scarcely be expected to catch the disease through haustorial connection, as in spiked sandal the young and small roots are dead and the small haustoria of healthy seedlings and young saplings are incapable of attacking the living larger roots of infected plants. Hence in the case of young stock, as in Experiment III, the plants probably get the disease through aerial infection. Do bushes protect the plants under their shelter from aerial infection? In our present state of knowledge, insect carriers are the aerial agents suspected to transmit the disease. As bushes form a natural habitat for insects, it can scarcely be expected that they would spare all the plants under bushes and attack only those which have overtopped them. The other factor that may account for this difference, is the effect of light and shade on the incidence of the disease. In some virus diseases, shading has been found to be highly beneficial to infected plants. In tomato "yellows" (9) shading has been found to increase the tolerance of the plant to the virus. In curly top of sugar beet (1) it has been found that high light intensity cause the development of severe disease symptoms. In infectious chlorosis of Abutilon, shading of infected plants result in the development of normal green leaves, and in some cases the plants appear even to recover from the disease.

In spike disease of sandal shade similarly may have a highly beneficial effect on the plants exposed to infection. It may make the

plants more tolerant of the virus, and also mask the symptoms of the disease. This was further supported by the following experiment in the sample plot, where the other previous experiments were conducted. Two groups of bushes were chosen near each other, containing saplings two to four feet high, the crowns of which were well inside the bushes, and all saplings cut back to one foot from ground. It is well-known that such cutting back of sandal will result in the expression of disease symptoms in cases where the disease was latent or masked. In one group containing 25 saplings the bushes were also cut down so as to fully expose the sandal plants while in the other group containing 27 saplings the bushes were left intact. When the stock cut back produced new leaves, 14 plants were spiked in the former and only three in the latter. In several localities it has been observed that even in the case of well grown sandal trees, where they are well shaded by larger associate species, the incidence of disease is markedly low as compared with areas such as scrub where sandal is fully exposed and dominates over associate species. For example in Closepet Range there is a well-wooded small plantation (Hondarkupee) adjoining the scrub forest of Chikkamannugudde. The plantation contains very large trees mostly of *Pongamia glabra*, and a few mange and *Eugenia jambolana*, with a fairly thick undergrowth of lantana. The trees are closely grown intermixed with 63 large sandal trees and the leaf canopy is nearly complete. Spike disease appeared in the scrub jungle and on the fringe of plantation in 1927 and 1928 respectively, and during the next six years, while the disease wiped out all the stock of sandal in the scrub, only 20 per cent. of the trees in the plantation were affected. The lower incidence of the disease in pole forests and other well-wooded jungles may be due to this factor of shade.

In this connection it may be argued that sandal trees in cultivated lands are completely exposed and hence the incidence of the disease should be high in such areas. Such exposed trees without the benefit of any shade might be more susceptible to the disease, but the contributory factor and the suspected store house of infection, that is, the undergrowth, is very scanty or altogether absent in such areas. When

cultivated lands are abandoned and rank vegetation is allowed to grow up below sandal, the incidence of disease becomes as severe as in scrub jungles.

SUMMARY.

(1) The spread of the disease in a southerly and south-easternly direction has been very rapid, but its progress towards the north has been very slow. In the sandal zone in Southern India, while the disease has reached the southern limits, the northern half of the Mysore State and the adjacent sandal areas in Dharwar, Canara and North Coorg are still entirely free from the disease.

(2) The incidence of the disease is highest in scrub jungles and lowest in cultivated lands and private holdings. In the oldest infected areas while most of the sandal has been wiped out in scrub jungles, the disease has made but little impression on the stock growing in adjacent cultivated lands and holdings.

(3) Undergrowth is suspected to be responsible for this difference as it is more or less dense in scrub jungles, and very scanty or altogether absent in cultivated lands and holdings. In abandoned holdings, where rank vegetation is allowed to grow, the disease is as severe as in scrub jungles.

(4) Among undergrowth, lantana is not the only species responsible for the spread of the disease. Thick undergrowth of other species in which lantana is absent is equally conducive to the spread of the disease.

(5) Spike like infectious diseases of *Zizyphus oenoplia*, *Dodonæa viscosa*, *Strachytarpheta indica* and *Vinca rosea* are probably not communicated to sandal, as haustorial connections failed to transmit the disease.

(6) Undergrowth is suspected to afford a suitable habitat to insect vectors.

(7) By actually growing sandal in infected areas, it has been found that even very young plants nine months old and 1′-3″ in height get spiked when grown in the open. The minimum incubation period in nature is therefore less than nine months.

(8) Such young plants growing under bushes have not been found spiked. In nature where all regenerations are only found under bushes, the young stock does not get spiked till it overtops or just before overtopping the bushes in which it is growing. Shade is suspected to have a highly beneficial effect on plants exposed to infection, by probably making them more tolerant of the virus, and it may also mask the symptoms.

(9) By placing potted sandal plants in a heavily infected area, it has now been proved that the disease also travels above ground, and insect vectors are strongly suspected to be the agents of aerial infection.

(10) All attempts to transfer infection through pollen and seed from partially spiked trees yielded negative results.

BANGALORE :
Dated 10*th August* 1934.

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SPRUCE REDWOOD TIMBER.

By Naranjan Singh, s.d.o., Parbatti.

While exploiting 1/20 Charithach C II in Parbatti sub-division of Kulu Forest Division during 1933, a considerable number of spruce trees were found to contain redwood, which is very heavy, and in its original form on conversion is unfloatable. With a view to utilise this timber it was decided to have it converted and then to let the converted scantlings lie in the forest or in the launching depot for one year and then to float it. It was expected that one year's seasoning will reduce the weight of the wood and render it floatable. As an experiment, a reasonable number of scantlings were weighed while freshly cut and after one year's seasoning. For comparison few whitewood sleepers were weighed too while freshly cut and after they have remained in the launching depot for a period of 4—5 months. The results are given below. The size selected for weighing was 10′ sleepers in each case.

I.—Redwood Sleepers.

Average weight of sleeper while freshly cut was found to be 2 maunds 38 seers,

After one year's seasoning in launching depot the average weight was found to be 1 maund 38 seers.

II.—Whitewood Sleepers.

Average weight of whitewood sleepers while freshly cut was found to be 2 maunds 8 seers.

Average weight of a whitewood sleeper after it has remained in the launching depot for 4—5 months was found to be 1 maund 18 seers.

2. In order to be sure whether the fresh cut whitewood and one year's seasoned redwood sleepers will safely reach the sale depot, an experiment to judge the absorption of water was made by immersion of the sleepers in a pool of water for one month.

In case of one year's seasoned redwood sleepers average weight after one month's immersion was 2 maunds 11 seers, *i.e.*, about 13 seers of water were absorbed during one month.

Ends of the sleepers under experiment were tarred up to 2″ from each end.

In case of freshly cut whitewood the ends of half the sleepers immersed in water were tarred up to 2″ and of half were left untarred. The absorption of water by those with tarred ends was found to be less than those with untarred ends.

Average weight of the sleepers with tarred ends after one month's immersion was found to be 2 maunds 18 seers and of the sleepers with untarred ends was 2 maunds 22 seers.

3. *Chil* (*Pinus longifolia*) 10′ sleeper with tarred ends after one year's seasoning on the bank of the river was found on average to weigh 2 maunds. After immersion for one month the average weight was found to be 2 maunds 18 seers. A freshly cut 10′ sleeper of *chil* with tarred ends is therefore heavier *in river* than our one year seasoned redwood sleeper with tarred ends and fresh cut whitewood with tarred or untarred ends *in the river*. Consequently considering that fresh cut *chil* 10′ sleepers with tarred ends reach sale depot safely, it was held safe to launch redwood spruce timber after one year's seasoning and freshly cut whitewood timber immediately after conversion.

Table showing trade in Teak between each Province and Indian State and Chief Seaport (in cubic feet) during the month of March 1934 *and in the* 12 *months,* 1*st April* 1933 *to* 31*st March* 1934.

Articles and whence exported.	IMPORTED INTO PROVINCES, EXCLUDING SEAPORT TOWNS, INTO STATES AND CHIEF SEAPORTS.									
	Assam.	Bengal.	Bihar and Orissa.	U. P.	Punjab.	Sind and British Baluchistan.	C. P. and Berar.	Bombay.	Madras.	Rajputana.
TEAK—										
Assam	..	3008·20	..	..	..	..	..	..	..	..
Bengal	137·06	..	156·64	3·56	..	..	..	..	..	..
Bihar and Orissa	..	..	..	..	..	..	..	..	..	..
U. P.	..	..	..	..	..	..	..	..	..	233·18
Punjab	..	..	..	..	..	..	..	..	..	1557·50
Sind and British Baluchistan ..	..	..	..	..	7·12	..	..	..	..	..
C. P. and Berar	..	4448·22	..	916·70	8969·42	..	..	3196·88	3707·74	..
Bombay	..	..	..	..	1765·76	..	..	..	11883·28	3·56
Madras	..	..	..	..	..	..	..	..	..	..
Rajputana	..	..	..	..	5·34	..	..	..	..	..
Central India ..	..	..	..	..	..	..	..	..	..	425·42
Nizam's Territory ..	..	..	..	92·56	..	..	..	..	11780·04	..
Mysore	..	..	..	..	..	..	..	471·70	247·42	..
Kashmir	..	..	..	..	..	..	..	..	..	..
Calcutta	23·14	6920·64	2066·58	3006·42	26507·76	..	..	..	..	1689·22
Bombay Port	..	..	..	55·18	14·24	..	103·24	35633·82	..	115·70
Karachi	..	..	..	..	863·30	3948·04	..	..	..	2180·50
Madras Ports	..	..	..	..	..	..	..	..	62794·84	..
Total for March 1934 ..	160·20	14377·06	2223·22	4074·42	38132·94	3948·04	103·24	39302·40	90413·32	6205·08
Total for 12 months, 1st April 1933 to 31st March 1934 ..	2370·96	186935·60	47990·58	78400·10	163861·46	41696·50	2570·32	553850·56	820419·80	103790·02

NOTE.—Maunds have been converted into cubic feet at the rate of 1 : 1·78 based on 1 ton=50 cubic feet.

Table showing trade in Teak between each Province and Indian State and Chief Seaport (in cubic feet) during the month of March 1934 *and in the* 12 *months,* 1*st April* 1933 *to* 31*st March* 1934.

Articles and whence exported.	Imported into provinces, excluding seaport towns, into states and chief seaports.									
	Central India.	Nizam's Territory.	Mysore.	Kashmir.	Calcutta.	Bombay Port.	Karachi.	Madras Ports.	Total for March 1934.	Total for 12 months 1st April 1933 to 31st March 1934.
TEAK—										
Assam	..	..	..	..	26·70	..	..	..	3034·9	21505·96
Bengal	..	..	..	..	283·02	..	..	..	580·28	69665·64
Bihar and Orissa	..	..	..	..	3·56	..	..	..	3·56	15062·36
U. P.	..	..	..	..	3·56	..	..	..	236·74	13024·26
Punjab	..	..	..	..		..	..	..	1557·50	29117·24
Sind and British Baluchistan ..	..	..	..	..	..	..	..	..	7·12	781·42
C. P. and Berar	1495·20	..	..	..	..	..	..	94·34	22828·50	158106·72
Bombay	..	1804·92	2447·50	..	..	3·56	..	8·90	17917·48	159639·30
Madras	..	195·80	89·00	..	..	..	..	3510·16	3794·96	65673·10
Rajputana	..	..	..	..	..	..	..	..	5·34	21·36
Central India	..	..	..	..	..	..	..	..	425·42	5808·14
Nizam's Territory ..	..	..	..	..	..	..	..	83·66	11956·26	75755·02
Mysore		..	..	..	..	..	..	..	719·12	11651·88
Kashmir	..	..	..	..	..	..	..	..	..	..
Calcutta	10·68	..	..	..	..	..	..	..	40224·44	341039·10
Bombay Port	83·66	651·48	..	..	..	..	..	..	36657·32	602216·72
Karachi	..	..	..	..	..	..	..	..	6991·84	73627·92
Madras Ports	..	3·56	4090·44	..	..	..	..	..	66888·84	661577·94
Total for March 1934 ..	1589·54	2655·76	6626·94	..	316·84	3·56	..	3697·06	213829·62	..
Total for 12 months 1st April 1933 to 31st March 1934 ..	37903·32	103193·72	80909·90	756·50	26473·94	4489·16	3·56	48658·08	..	2304274·08

NOTE.—Maunds have been converted into cubic feet at the rate of 1 : 1·78 based on one ton=50 cubic feet.

Table showing the trade in Other Timbers between each Province and Indian State and Chief Seaport (in cubic feet) during the month of March 1934 *and in the* 12 *months,* 1*st April* 1933 *to* 31*st March* 1934.

Articles and whence exported.	IMPORTED INTO PROVINCES, EXCLUDING SEAPORT TOWNS, INTO STATES AND CHIEF SEAPORTS.									
	Assam.	Bengal.	Bihar and Orissa.	U. P.	Punjab.	Sind and British Baluchistan.	C. P. and Berar.	Bombay.	Madras.	Rajputana.
OTHER TIMBERS—										
Assam ..	..	27687·90	683·52	11822·76	..	..	..	..	..	..
Bengal ..	11657·22	..	103110·06	15875·82	..	..	..	..	..	5·34
Bihar and Orissa ..	16·02	144324·18	..	164555·66	6895·72	..	758·28	21509·52	45306·34	40418·46
U. P. ..	..	128·16	75128·46	..	694269·42	12878·30	43077·78	28·48	3·56	125242·58
Punjab ..	..	..	..	16199·78	..	61650·30	..	8·90	7·12	27422·68
Sind and British Baluchistan ..	..	..	..	..	94·34	..	..	..	..	2799·94
C. P. and Berar ..	..	206·48	1669·64	52453·04	3903·54	..	..	197535·50	18156·00	16730·22
Bombay ..	..	..	..	979·00	178·00	..	1059·10	..	12641·56	29190·22
Madras ..	..	..	..	..	..	..	665·72	601·64	..	..
Rajputana ..	..	..	..	267·00	1450·70	356·00	5·34	265·22	..	..
Central India ..	..	..	..	17634·46	16416·94	..	3494·14	2808·84	..	5660·40
Nizam's Territory	..	..	..	..	..	..	..	37·38	50592·94	..
Mysore ..	..	..	..	2828·42	..	..	..	1·78	8707·76	..
Kashmir ..	..	..	..	..	14·24	..	..	..	..	..
Calcutta ..	8811·00	13636·58	6954·46	1737·28	3·56	..	..	..	24·92	..
Bombay Port ..	..	..	..	512·64	58·74	..	366·68	32365·74	380·92	412·96
Karachi ..	..	..	..	103·24	26·70	17088·00	..	..	..	74·76
Madras Ports ..	..	..	..	7·12	..	..	..	60·52	28836·00	..
Total for March 1934 ..	20484·24	185983·30	187546·14	284976·22	723311·90	91972·60	49427·04	255223·52	164657·12	247957·56
Total for 12 months, 1st April 1933 to 31st March 1934	161221·72	2401864·36	976675·32	1830156·84	3230844·18	730367·82	295002·96	2393163·72	1423547·88	1231923·76

NOTE.—Maunds have been converted into cubic feet at the rate of 1 : 1·78 based on 1 ton=50 cubic feet.

Table showing the trade in Other Timbers between each Province and Indian State and Chief Seaport (in cubic feet) during the month of March 1934 and in the 12 months, 1st April 1933 to 31st March 1934.

Articles and whence exported.	Imported into provinces, excluding seaport towns, into states and chief seaports.									
	Central India.	Nizam's Territory.	Mysore.	Kashmir.	Calcutta.	Bombay Port.	Karachi.	Madras Ports.	Total for March 1934.	Total for 12 months, 1st April 1933 to 31st March 1934.
OTHER TIMBERS—										
Assam ..	..	..	..	..	14156·34	..	..	..	54350·52	731677·90
Bengal ..	..	..	..	..	191394·50	..	..	..	322042·94	1770005·30
Bihar and Orissa	..	11856·58	986·12	..	53387·54	7276·64	..	4330·74	501621·80	3451727·94
U. P. ..	8303·70	..	..	..	62·30	23·14	5·34	..	959151·22	4392176·70
Punjab ..	712·00	..	..	3410·48	69·42	920·26	930·94	..	111331·88	1034890·22
Sind and British Baluchistan ..	..	..	..	..	..	..	809·90	..	3704·18	76488·38
C. P. and Berar ..	64934·40	15411·24	..	..	15927·44	16911·78	..	715·56	404554·84	3098332·08
Bombay ..	33686·50	5865·10	170·88	..	..	22753·74	..	2728·74	109252·84	817244·28
Madras ..	..	2415·46	23154·24	..	..	24·92	..	82876·80	109738·78	922493·90
Rajputana ..	535·78	..	..	..	..	7·12	..	..	2887·16	59516·08
Central India ..	..	1·78	..	..	..	806·34	..	..	46822·90	419266·54
Nizam's Territory ..	..	..	..	..	..	85·44	..	1·78	50717·54	376971·96
Mysore ..	..	..	..	..	..	..	..	3298·34	14836·30	229324·52
Kashmir ..	..	..	..	..	..	..	..	..	14·24	14174·14
Calcutta ..	..	..	1132·08	..	..	..	..	5·34	32305·22	399250·44
Bombay Port ..	865·08	1130·30	201·14	..	5·34	..	..	97·90	36397·44	445503·74
Karachi ..	..	..	..	..	..	..	..	..	17292·70	160634·32
Madras Ports ..	..	153·08	60·52	..	..	..	..	..	29117·24	427878·18
Total for March 1934 ..	109037·46	36833·54	25704·98	3410·48	275002·88	48809·38	1746·18	94055·20	2806139·74	..
Total for 12 months, 1st April 1933 to 31st March 1934	701303·98	208989·80	229833·60	45318·80	1713711·02	371664·00	13458·58	868508·28	..	18827556·62

NOTE.—Maunds have been converted into cubic feet at the rate of 1 : 1·78 based on 1 ton=50 cubic feet.

EXTRACTS.

ANGLING HAS SCIENTIFIC ANGLES.

By J. E. Nielsen, B.Sc.

To one who is not a fisherman, angling appears to consist of endless waiting and watching for a jerk or tremor in a line with a baited hook, requiring patience far in excess of any other sport.

An angler, however, has abundant time to reflect about countless problems and, besides, the open air provides good appetite. Therefore angling is a healthful and interesting distraction. Furthermore, by the use of scientific methods it can be developed into an intelligent, scientific recreation with a string full of proof to satisfy the acquired appetite.

The average fisherman uses methods and equipment which are based largely on the oratorical gifts of the salesmen in sporting goods stores. It is remarkable how few are the fishermen who really know the scientific reason for success in fishing or the lack of it. They unwisely put themselves in the place of the fish and assume the fish to react as they themselves would if they were confronted with a baited hook. This, for example, is why they believe that the most important property of a float line is that it must not be seen. The fact is that, if the fish should rely on its eyesight alone, all fishermen would be successful. However, because of a difference between air and water the sensory organs of fishermen and fish have developed along different lines. Fish do not see or hear or smell—nor do they taste or feel—as we do, and the different sensory organs are of necessity constructed in quite a different manner in a fish.

In order to allure fish it is therefore necessary to know just what are the important senses of the fish, and how it seems when one puts oneself in their place—the fish, instead of the fisherman.

Take first the sense of vision. In the human eye, light rays enter the first lens through the cornea, which contains a transparent fluid of refractive index the same as water, namely, 1·33. Next it passes through the pupil to the second lens, which has a refractive index of about 1·141. From this it proceeds through almost pure water to the retina, where the image is picked up by the optic nerve.

This device of sight is highly efficient in air, which has a refractive index of 1·00, but when immersed in water, which has a refractive index of 1·33, it is very inefficient. The reason for this is that, as is shown by the principles of optics, light rays which enter the eye will then not be refracted by the first lens but will go through to the second lens in a straight line, and this will have a relative refractive index of only $1{\cdot}41 \div 1{\cdot}33$, or 1·06, which is too low to make possible a sharp image on the retina.

In order to improve upon the low refractive power of the eye of a fish, nature has increased the curvature of its only active lens to the maximum possible, which is the sphere. As we know from optics, the disadvantage of a spherical lens is that

only the very central rays will give a tolerably clear image. It exhibits marked spherical aberration. This, combined with the low refractive index, makes fish very near-sighted animals. They are able to sense changes in light intensity, but are unable to distinguish between the forms of objects. We then draw the conclusion that the visibility of the float line and hook has no influence on fishermen's luck. We may also see that a flash reflected from a shining spoon or wobbler may allure with the same power as the reflection from the side of a fish.

Next, hearing. In fishermen the ear is divided in three parts: The external, the middle, and the internal ear or the labyrinth. Fish possess only this latter part. The reason for this difference is clear. The function of the ear is to collect vibrations of various frequencies. In the case of humans the ear is surrounded by air and the funnel-shaped external organ is an efficient device for collecting these vibrations, because the medium in which they are set up has a density of only one-thousandth of that of which the ear is built. Fish, on the other hand, are surrounded by a medium having the same density as that of which they are built, and their whole body partakes of the vibrations set up in this medium. The labyrinth is the only organ required to transfer the physical vibrations to the nervous system. As the receiving nerve centres of a fish are built much the same as ours, we may assume that its sense of hearing is similar to ours—possibly better, on account of the high density of water with which the nerve centres are in direct communication.

Hearing and feeling are closely related senses and in the case of fish there is no definite borderline between the two. In addition to periodic sound waves there are other waves—non-periodic pressure waves which humans cannot perceive. A worm wriggling in the water or an insect falling on the surface will set up waves of pressure in the water around them and these will instantly be noticed by the fish. For this purpose, it has an extremely suitable organ, the "lateral line." As we, ourselves, do not possess this organ, it is difficult for us to imagine how its sensations feel, but there is no question that its sensitiveness is far superior to that of fish vision. This fact is affirmed by the strong lateral nerve system connected to it. The best analogy we can give is that of a blind man with his stick, but the fish has long "sticks" in all directions, and every stick has a sensitivity equal to the tip of your tongue—every stick is in fact a "teletoucher." Most fishermen do not pay much attention to this organ, but it is nevertheless the organ which causes more bad luck among fishermen than all the other senses combined. With this organ, fish are able to feel the least "touchiness" in the surrounding medium.

We therefore draw the next conclusion that fish are more "touchy" than fishermen, and that we should pay closer attention to arranging the float line so that it will be as little likely as possible to excite the special touchy sense of the fish by setting up unnatural vibrations in the water.

The chemical senses, smell and taste, which are separated in fishermen, are combined into one by fish. As the nature of smell is to perceive odorous matter highly diffused in air, and as fish are not surrounded by air, there can be no sensation of smell as it is known in fishermen. There may, however, be a better developed sense

of taste, judging from the abundant distribution of taste buttons in and around the mouth and on the sides of the head. It is possible that fish can taste matter highly diffused in water as easily as we smell it in air. Taste and smell are quite different sensations. It is only occasionally that an agreeable smell arouses our desire to eat. Some fine perfumes, for example, have a definitely disgusting taste. The practice of some fishermen of perfuming the bait is useless and unscientific. There is no reason to assume that fish should want violet perfume included in their diet, merely because we like the smell of violets. Most of the " wonderful " prepared baits and prescriptions for baits can be classed as hokum.

Expert fishermen will tell you that, when it comes to catching fish for the sake of the fish more than for exercise and fresh air, there is nothing more killing than natural bait, preferably live and employed in not too large a quantity. Of this the easiest obtainable is the ordinary pink earthworm, which should be kept in a can with moss. Even on the hottest day there are few fish which will not risk stretching the skin of their bellies a bit more, just to accommodate a nice worm when it starts telegraphing its arrival in the vicinity.

A live bait should always be presented to the fish in as natural a condition as possible. A worm which is threaded on a hook will not be able to broadcast the same pressure waves as a free worm and, by the lateral line previously mentioned, the fish will sense danger. Therefore a better way is to hook the worm twice through the skin, about an inch from either end. Other live baits should be presented in a similarly natural way, with as little interference with its broadcasting as possible.

You will often notice that some fishermen, after having waited for some time, pull up the line and change the bait. They may do this repeatedly without the possibility occurring to them that something other than the bait might be wrong. If the bait is properly attached and if the fish refuses to take it, one may make a fair guess that it is the line which is wrong and that its presence is being sensed by the fish—it occasionally happens that they refuse to commit suicide. If the fish senses the float line, the latter must be perfected so that it cannot be detected. Such a line is, however, not to be had on the market, and we must do as real fishermen do—make it up ourselves.

Let us first visualize how we should approach a bait if we were the fish and not the fisherman. First, with our teletoucher, the lateral line, we should feel the wriggling of the worm or the flapping of the fins of a small bait fish at quite a distance, and we should be able to judge the distance and the direction very closely. We might even, if we should stay in one spot for a short time, get a hint of taste now and then from the appetising bit of nourishment. Still, we do not approach because simultaneously with these pressure waves we feel other vibrations closely associated with the bait which warn us of danger. These vibrations are caused by the float line. We also have the feeling that the bait itself is being moved about in the water in a manner which is not natural for a worm. This is caused by the float following the up and down motion of the waves on the surface. Being a smart fish we do not take the bait, in spite of a healthy appetite. If the surface is quite calm, we may slowly approach it and even touch it, but this touch will instantly tell us that there is something wrong, for the resistance against displacement is different from what we should expect.

Among all these appetizing bits that act unnatural, however, we suddenly feel one which acts quite natural, and after a brief hesitation we go straight after it. Coming very near, we taste it more strongly and see its colour. We get so close that we can nibble at it, and we see that there is no noticeable resistance. We decide to take it. To our despair we find that we are caught by fishing tackle whose presence we had not been able to perceive even with our teletouchers and special senses. This tackle is a perfectly balanced float line, its surface friction and volume reduced to a minimum.

In order to reduce surface friction we must discard all float lines of cotton, silk, catgut, and so on, as the fine fibres on the surface of these materials give a high frictional resistance. There remains the choice between horsehair, Italian or Japanese gut of the finest size, and metal wire. Of these, horsehair is too weak, even for small fish, and can be counted out. Italian and Japanese gut has a tensile strength of about 50,000 pounds per square inch cross-section and the finest of this is about nine-thousandths of an inch in diameter. This can, therefore, sustain a weight of about three pounds. In metal, only chrome nickel wire is obtainable in suitable sizes. This can be obtained at radio stores, where it is sold as resistance wire. Only gage 40 to 31 is of interest to us as float lines. The tensile strength of this wire is about 150,000 pounds per square inch of cross section. A 31-gage wire, which is nine one-thousandths of an inch in diameter, will carry about 10 pounds, while gage 40, which is three one-thousandths of an inch in diameter and like a fine hair, will carry a weight of one and a quarter pounds. A 36-gage wire will have the same strength as the finest gut, while its surface will have only about half as great an area. Therefore its frictional resistance in water will be only half, and its volume will be a quarter, of that of the gut line. This line will then be twice as difficult for a fish to detect when nibbling, and four times as difficult to feel by means of its lateral line at a distance. If given a fine coat of black lacquer, it will also be invisible to any fish that does not wear spectacles to correct its poor eyesight.

Having made this choice of material, we now build our line on the principles of least resistance against lateral movement. We use as little sinker as possible, dividing it up into small quantities and distributing these along the line. We place the first little ball about 12 inches from the hook, the next one 10 inches farther up, the next again 8 inches, and so on—6, 4, and 2 inches apart if we need that many. It is all a question of how fast we want the line to sink. We now place the float so that the bait will hang at the desired depth—on a hot day quite deep, on a cloudy day higher up, all depending on locality, wind, and weather—and we balance it so that it will just float on the surface, in order that the least additional weight or the least touch of the hook will pull it down under the surface.

Having done this, the float is now divided into two parts, a large part and a small one. We place the large part about 18 inches nearer to the hook than the other. Then it will be totally submerged in the water below the surface waves, while the little float above will remain on the surface and participate in the motion of the waves on the surface.

By this arrangement we shall obtain a perfectly balanced float line with which fish can be caught even under the most difficult conditions. It will be found also that fish caught on such a line are usually well hooked.

Of course, fish can be caught with any kind of line, provided they have a good disposition or are famishing. Unfortunately the latter is not always the case, and at such times he who has the better tackle will usually have the better luck which all goes to show that Pritt was right when he said that one of the charms of angling is that it presents an endless field for argument, speculation, and experiment.—(*Scientific American*, July 1934.)

TREE RINGS AND HISTORY.

By R. Maclagan Gorrie, D.Sc.

(*Reprinted from* " *Sylva* 1935.")

The application of tree rings in dating archæological and historic puzzles has probably been thought of by many biologists, but it was first put into practice by an astronomer. Dr. A. E. Douglass of the University of Arizona attempted in 1901 to use tree ring data as evidence in demonstrating the occurrence of climatic cycles corresponding with sunspot maxima. If many widely separated trees in a uniform area show the same variations in the same years continuously over centuries, then this must give an accurate picture of local climatic variations, for climate is the common continuous factor in their lives. Having traced such cycles back amongst the oldest living trees it was only a step further to link up the growth cycles of timber and charcoal specimens found in prehistoric dwellings and caves with these of modern timber, establish a dating table to match the ring patterns, and so provide a really reliable chronology. As an instance of the value of his work, the archaeologists have had to revise their estimate of the age of the early Pueblo culture of the South-Western States, coming from 6000 B.C., down to nearer 500 B.C.

This work however is not easy and has entailed an enormous amount of research which Dr. Douglass has succeeded in carrying through along with his routine work as astronomer and lecturer As his experience is of value to foresters in improving the technique of ring-counting work, so inevitably associated with working plan and silvicultural field duty, a short account of his system may be of interest. During a recent sojourn in Tucson, Arizona, while on a Leverhulme Research Fellowship tour, I had the privilege of spending an afternoon with Dr. Douglass in his laboratory which is already overcrowded with ring-count specimens dating back into the dim past.

The bulk of this tree-ring work has been done on conifers, chiefly *Pinus ponderosa* and *edulis*, Douglas fir, juniper, and the big tree (*Sequoia gigantea*), and the best correlation is from trees growing in severe conditions, such as the fringe of the desert or where moisture is not readily obtained by the tree. Thus the coastal redwoods (*Sequoia sempervirens*) growing in the Californian fog belt are what Dr. Douglass calls " complacent ; " they have too easy a life and their ring development is too regular to serve the historian's purpose. For a very large area of the South-West, however, the climate is severe enough to develop growth rings of very variable size, and the most useful pattern or " signature" is some recognisable sequence of broad and narrow rings. In many instances the narrow rings formed in particularly bad drought years are so microscopic as to be missed entirely, even with a good hand-lens ; and this is a point of direct significance to the forester, for if many such rings are omitted

from ring count, the effect will be to reduce the calculated rotation age below what it ought to be. On the other hand, false rings caused by a split rainfall season are common, and can only be tested by the absence of the sharp line of summer wood which inevitably finishes off the outer edge of the true ring. The usual ring-counters' argument that a ring is false if it telescopes into its neighbour is apparently quite wrong, because many true rings do this, whereas false ones do so less frequently. The acid test is the presence of the hard line where summer wood has ripened off.

The handiest form for the study of specimens is in a V-shaped cut from the butt log or stump, stretching from the bark to beyond the centre of the trunk so as to include the whole of the first few central rings. This is certainly preferable to developing housemaid's knee by brooding over the stump itself! Specimens from living trees and from old timbers in position in historic buildings are best obtained with a brace-bit turning a long hollow steel pipe, the edge of which is serrated saw-fashion; this gives a sample of the same kind as a Pressler's borer, but larger and going right to the heart of the tree. The surface of the specimen to be used for reading the rings is best prepared by shaving off a narrow corner with a razor drawn radially across the rings (Shades of the Forest Botany Lab and its insistent mentor!); and the rings can be made to show up better if the surface is wet with paraffin.

A pin is put in at every tenth year and a series of shorthand notes made of the relative size of rings; then a rough graph is made on squared paper, allowing a unit of the base for each annual ring, and narrow rings are marked by upward lines in inverse proportion to their width, so that the narrower the ring the taller the line. This is done because very narrow rings are of most use in diagnosis.

The process of cross-dating is done by comparing a large number of such graphs for trees of a period until a common sequence can be recognised, and if such a sequence can be worked out, it will incidentally give a most accurate history of the climate for the region in question. Dr. Douglass has shown that in a great many instances a climatic cycle corresponds with the sunspot maximal interval of 11·2 years, though this is by no means inevitable, as other factors beside sunspots influence local climate, and the sunspot cycles themselves show occasional lapses at somewhat long intervals, being influenced by various astronomic factors. Many *Sequioas*, for instance, show in addition quite definite cycles of 8·5 and 14 years.

If and when a cross-dating sequence has been established for your local climate, you can then go forward to the help of the archæologists by doing the same thing for the available samples of old timber and charcoal. The charts for the different periods can then be dovetailed into one another so that the sequence of ring patterns can be established from the living tree, back through the historical specimens, and finally the whole can be dated with considerable accuracy, provided that all the elusive microscopic rings of the bad years have been duly accounted for. This bridge method correlates two or more records of different historical periods so as to cover the gap between ancient and modern with a complete picture of the intervening climatic developments. In the case of the Arizona and New Mexico material Dr. Douglass had to wait many years before a gap in the years prior to 1300 A. D. was eventually filled from material collected by a National Geographical Society expedition.

INDIAN FORESTER

APRIL, 1935.

PROPAGANDA IN FORESTRY.

It is high time Forest Officers gave up the idea of isolation and complete disregard of what opinion the public entertains about Forestry. In the past the Forest Service received full support from the Government but with the new Reforms it will not only be necessary but most essential to enlist the sympathies of the general public and in particular the educated classes, legislators in particular, and those who are directly or indirectly connected with Forestry. The activities of the Department will be subject to considerable criticism in the Councils and it is important that we make a start to view our activities from a different angle. On one side we should launch an organised propaganda against wood substitutes, and the biggest item at present replacing the use of wood in India is reinforced concrete. We are now in a position to recommend the use of treated wood as a very reliable article of use in building construction and a comparatively cheaper proposition.

The present attitude may be summed up as a complete disregard of the enormous quantities and kinds of substitutes being put in the market and the attitude of the general public towards Forestry. The educated classes still understand Forestry as merely cutting and selling trees, and the rural population regards it as merely an unavoidable evil.

It is not enough to produce our wares and sit in the hope that they will be marketed. We have to justify our expenditure and our mere existence so that we must not only produce timber, but produce it at a cost so that we can sell it as a commodity better than the substitutes and at comparatively cheaper prices. We must convince the educated classes that the existence of forests is essential for the

welfare of society, and that the interests of Forestry are the interests of the public. What are we doing in this direction ? Is it below our dignity to go out of our routine duties to enlist the sympathies of the legislator and of the rural classes in what is essentially their own estate maintained for their own benefit ?

We have in some provinces sets of magic lantern slides, but we do not remember to have read in any annual report that they were used during the year, and if they were used at all, what was the number of audience who went away with a new idea about Forestry. Surely each province can afford to single out one or two officers to devote all their time to propaganda work alone. Would it be too much to ask if the provinces would include in their Annual Reports a few lines on propaganda work and compare their activities from year to year. We know that in some countries—Canada in particular—where this work has been done on right lines, the people have gone away with changed ideas to tell everybody what should be the right attitude on the working of an important public department. It is for the provinces to decide if whole-time men should be detailed to do this work or it may be left with individual Divisional Forest Officers who should again include in their Annual Reports the amount of propaganda work done in their areas. Perhaps a combination of the two would suit all localities.

A start can be made in Colleges and High and Secondary Schools, and gradually village communities can be interested, and magic lantern or cinema shows held once annually in important centres of the Divisions would go a long way to advance the cause of Forestry in the country. There is no doubt that people would flock to see the *tamasha* at no cost to themselves and at very little cost to the Department. If all Forest Officers give up the proverbial isolation to which most of them—the enlightened few who have done their bit to interpret Forestry to the public excepted—are accustomed and take advantage of all opportunities of meeting and discussing matters with village communities as ordinary human beings, there is absolutely no doubt that the cause of Forestry will be well served. There is always some

work of public utility like water tanks for cattle, drinking water supplies, requirements for the mosques and temples which are hanging fire for want of money, and if the Forest Officers could persuade the local population to collect subscriptions for such items of public utility by charging small fees for such magic lantern and cinema shows they will not only endear themselves in the minds of people but will create a lasting interest in the cause for which we stand.

The Forest Research Institute has a set of lantern lectures which can be borrowed and the Inspector-General of Forests is desirous of collecting suitable cinema films which can be usefully employed in such propaganda. In fact a start has been made and within a reasonable time it is hoped that certain lengths of films will be available for the provinces which can be shown in rural areas even where no electric current is available: If certain lengths of films of humorous and of general interest can also be included this type of propaganda can become a sure success.

There is no doubt that if every province were to circulate the particulars of magic lantern slides and cinema films they have for loan to other provinces, a good deal of work can be done without waiting any length of time.

We shall look forward to hearing more of these activities in future annual reports.

ALL-INDIA CONFERENCE FOR THE PRESERVATION OF WILD LIFE.

Resolution adopted at the meeting of January 30th, 1935.

Resolutions under item No. 1 *of the Agenda.*

1. From a general review of the position of the fauna of India the Conference recommends—

That the following species are deserving of special consideration :—

1. All kinds of rhinoceros ;
2. Wild ass of Sind ;
3. Sind ibex ;

4. Kathiawar lion ;
5. Musk deer ;
6. Cheeta ;
7. Buffalo ;
8. Monitor lizard (except in the Punjab) ;
9. Pangolin ;
10. Caracal ;
11. Brow-antlered deer ;
12. Pink-headed duck ;
13. White-winged wood duck.

That all Provinces and States where these animals or birds are found should be asked to co-operate in order to afford them necessary protection and to prevent them from being exterminated.

2. The Conference agrees that the duty of preserving the fauna in areas under its charge should be definitely laid on the Forest Department but, at the same time, urges the necessity of co-operation on the part of the Police and Magistracy.

It recommends—

That revenue derived from the following sources should be ear-marked for the protection of game and the payment of rewards :—

Shooting, fishing or game licenses.
Fines for breaches of game laws.

That there should be the closest co-operation between the Forest Department and all associations, the object of which is the preservation of game and wild life. Where such associations cover large areas, they would be well-advised to form local committees.

The Conference is of the opinion that a portion of the money ear-marked as recommended above should be allocated to approved associations for the preservation of wild life.

3. The Conference recommends—

(1) That the introduction of Nature Study as an optional subject in secondary schools be brought to the notice of the Educational Departments of Provincial Governments, Wild Life Associations and Boy Scout Organisations.

(2) That the attention of the Educational Departments be drawn to the need for the provision of better facilities for the training of teachers in Nature Study and particularly as regards the provision of suitable books of assistance to them in teaching the subject.

(3) That more use be made of museums for the teaching of Nature Study and financial assistance be given them for lectures in Natural History.

(4) That suitable lantern slides for illustration purposes should be provided.

(5) That steps be taken to issue cheap publications in various vernacular languages suitable for popular instruction.

4. The Conference recommends—

That Forest Departments should deal with game preservation in a separate section of their annual reports, noting the numbers of animals shot and any particulars of the increase or decrease of animals or birds in their areas.

5. The Conference recognizes the valuable work of existing Natural History Societies and trusts that the activities of existing societies will be extended and new ones started.

6. The Conference recommends that all local Governments who have not already done so should seriously consider the possibility of detailing one or more of their forest officers for the special duty of preservation of wild life as also the advisability of appointing suitable persons as Honorary Game Wardens with the powers of Forest Officers to enable them to give effective assistance in the preservation of the fauña and flora in their neighbourhood.

7. The Conference recommends that a strict ban be placed on cinema pictures which are likely to create terror and consequently hatred for wild animals among the public, specially children.

Resolution under item No. 2 of the Agenda.

The Conference considers the inoculation of village cattle against rinderpest as carried out in the Bison areas in Madras and experimentally in Bihar and Orissa and now proposed in the United Provinces

for the protection of deer, in co-operation with the Veterinary Department, to be of great importance, not only for the protection of the game but also for domestic cattle and recommends that protective inoculation should be extended wherever possible.

Resolutions under item No. 3 of the Agenda.

The Conference is of the opinion : -

1. That the essential and basic necessity in preventing the undue destruction of wild birds and animals outside forest areas lies in the prohibition, or at least the control, of the sale, purchase or possession of such birds or animals, whether dead or alive, and of all parts thereof.

2. That if the total prohibition of sale, purchase or possession is found to be impossible, it is important that there should be control by license and that this form of control should include the maintenance of registers of sale and purchase and should further place on the licensee the onus of proving that purchase has been through a legally licensed channel. Taxidermists should be included in any licensing scheme.

3. That in any system of licensing it is important to differentiate between "killing, capture or possession" on the one hand, and "buying, selling or offering for sale" on the other.

4. That the netting, trapping, snaring or noosing of wild birds or animals needing protection should be prohibited throughout the year or, if it is necessary to permit this under license, the rules should allow local authorities to settle from time to time the number of such licenses which should be granted in any area and the dates between which they should be valid.

5. That certain animals and birds requiring special protection should be scheduled by local Governments and brought under the definition of "forest produce" in Section 2 (4) (*a*) instead of 2 (4) (*b*) of the Indian Forest Act, 1927.

6. That in certain cases (such as the Sind ibex and the wild ass of Cutch) a special agency must be provided for the protection of

particular species by the Government or Governments concerned and, in the special case of the wild ass and the Indian lion a convention between the States concerned is necessary.

7. That in any legislation that may hereafter be enacted by local Governments, a clause should be inserted to allow of the notification from time to time of any species or part thereof as "contraband," that is to say, its possession, except under a certificate of origin, should be unlawful.

8. That the attention of Governments should be drawn to the growing and evil practice of shooting, hunting or chasing wild animals from or in the immediate vicinity of wheeled vehicles, particularly motor-cars and that a strong recommendation be made to local Governments to take steps to check this unsporting and destructive method of destroying animals both inside and outside reserved forests.

9. That shooting by artificial light should be prohibited at all times except, with the special permission of local Governments, in the case of animals classed as vermin.

10. That watching in the neighbourhood of water or salt-licks to shoot animals, other than carnivora, should be prohibited.

11. (*i*) That the importance of protection of fish should be recognized by local Governments, not only from a sporting but also from an economic point of view. This should include legislation against—

(*a*) The prevention of access to breeding waters.
(*b*) The destruction of fry in breeding area.
(*c*) "Fixed engines" in streams and especially those which prevent the movement of fish to and from breeding waters.
(*d*) Killing fish by the use of explosives.
(*e*) Poisoning of water.

(*ii*) That the protection of fish be put under authorities responsible for game protection where this is practicable.

12. The Conference welcomes the recent legislation enacted under the Punjab Wild Birds and Animals Protection Act but is of the opinion that, unless offences under this Act are made cognizable, its

enforcement will be rendered very difficult. It is further of the opinion that similar legislation, but with the amendments suggested above in paragraphs 3, 6 and 7, could be adopted by other provinces with advantage.

13. The Conference strongly recommends the formation of societies for the protection of wild life in areas where they do not already exist, and is of the opinion that one of their principal duties should be to assist in the enforcement of such legislation as may be adopted for the preservation of wild life in their areas.

14. The Conference emphasizes the importance of educating public opinion as, without strong public support, no efforts to preserve wild life can be effective. It therefore recommends that societies for the protection of wild life should make propaganda a principal part of their work.

Resolution under item No. 4 of the Agenda.

The Conference recommends—

(1) That all free guns licensed for the protection of crops should be restricted to single-barrelled smooth bore muzzle-loaders.

(2) That license in Form No. XVI should have the particular sport / protection / display specified, that permits for sport should only be given to *bona fide* sportsmen whose status is such as to warrant such a license.

(3) That in Thanas near forests the Forest Officer or the local Shooting Club, if any, should be consulted before new licenses for sport are granted.

(4) That retainers' licenses if allowed at all should be strictly limited.

(5) That licenses in Form No. XIX should be limited in number and the area for which the license is valid should be specified and restricted to the holding or village concerned.

(6) That selected police and forest officers should be empowered under the Arms Rules to demand the production of a licensed weapon at any time.

(7) That ammunition for licenses for protection or display should be limited to a definite number of rounds.

(8) That an entry of the quantity of ammunition purchased by a licensee should be entered on his gun license.

Resolution under item No. 5 *of the Agenda.*

The Conference recommends—

(1) that the Government of India should assume the obligations contained in Article 9, paragraphs 3, 8 and 9, as permitted under Article 13 (3) of the Convention concluded at the International Conference for the Protection of the Fauna and Flora of Africa in respect of all their territories.

(2) That steps should be taken to draw up an All-India Convention.

Resolution under item No. 6 *of the Agenda.*

The Conference considers that the convening of an Asiatic Conference at the present moment would be premature but is of the opinion that such a conference is desirable in the interests of Asiatic wild life and that when such a Conference is held, India should be represented.

FLUORESCENCE OF WOOD UNDER ULTRA-VIOLET LIGHT.

By S. Krishna and K. A. Chowdhury.

It has been known for a long time that aqueous extracts of certain timbers exhibit fluorescence when viewed in sunlight. Stone (7), for instance, mentions this phenomenon in the aqueous extract of the bark of horse chestnut (*Aesculus hippocastanum*), ash (*Fraxinus excelsior*), Chinchona species, and in the extract of the wood of African and Indian *padauks* (*Pterocarpus* spp.). Similar observations have also been recorded by Kanehira (3, 4) in the case of a number of Philippine and Formosan woods and by Brown (1) in Indian timbers (*Pterocarpus santalinus*, *P. macrocarpus*, *Ougeinia dalbergiodes*, *Mitragyna parviflora* and *M. diversifolia*). This phenomenon, however, is not general and is restricted only to the extracts or infusions of the bark or wood of certain species, which by themselves seldom show any

fluorescence, when viewed in sunlight, and as such was never considered as a definite criterion amongst the physical properties of timber.

Fluorescence, which in a large number of substances, both organic and inorganic, is weak and indefinite in sunlight, is greatly intensified when viewed in ultra-violet light. Bodies which exhibit little or no fluorescence when viewed in sunlight begin to show brilliant and often characteristic fluorescence under this light. It is thus a new aid to analytical work and is finding increasing application in the characterization of a variety of products. Hitherto, the application of this method to the study of wood has been very scanty. In 1928 Wislicenus (6) reported that the wood of *Acacia* exhibits fluorescence under ultra-violet light, and later Vodrazka (6) made similar observations on *Robinia*, *Ailanthus* and *Rhus*. Recently, Dalton (2) has described the nature of fluorescence exhibited by various woods in ultra-violet light. We have also made similar observations on several Indian timbers, in the form of wood blocks and powder or their extract in some common organic solvent. Some of the timbers examined by us were the same as in Dalton's list and as our findings differed from his we think it desirable to put on record the results of our preliminary study. In some of the species the fluorescence is very striking and we are inclined to think that a systematic study of this phenomenon, co-relating the nature of fluorescence with the constituents of the timber and its anatomical structure, may prove of value as an aid to identification. The colour and nature of fluorescence exhibited by a timber is apparently dependent upon the proportion and distribution of its constituents such as starch, colouring matter, gums and resins, etc., and it has already been noted by different workers that these constituents show different fluorescence under ultra-violet light. For instance, starch gives a blue fluorescence, colouring matters a yellow, resins an orange and so on. The study of fluorescence of wood under ultra-violet light thus opens up the possibility of locating these substances in different parts of the wood. Such a study is likely to be of interest from several points of view.

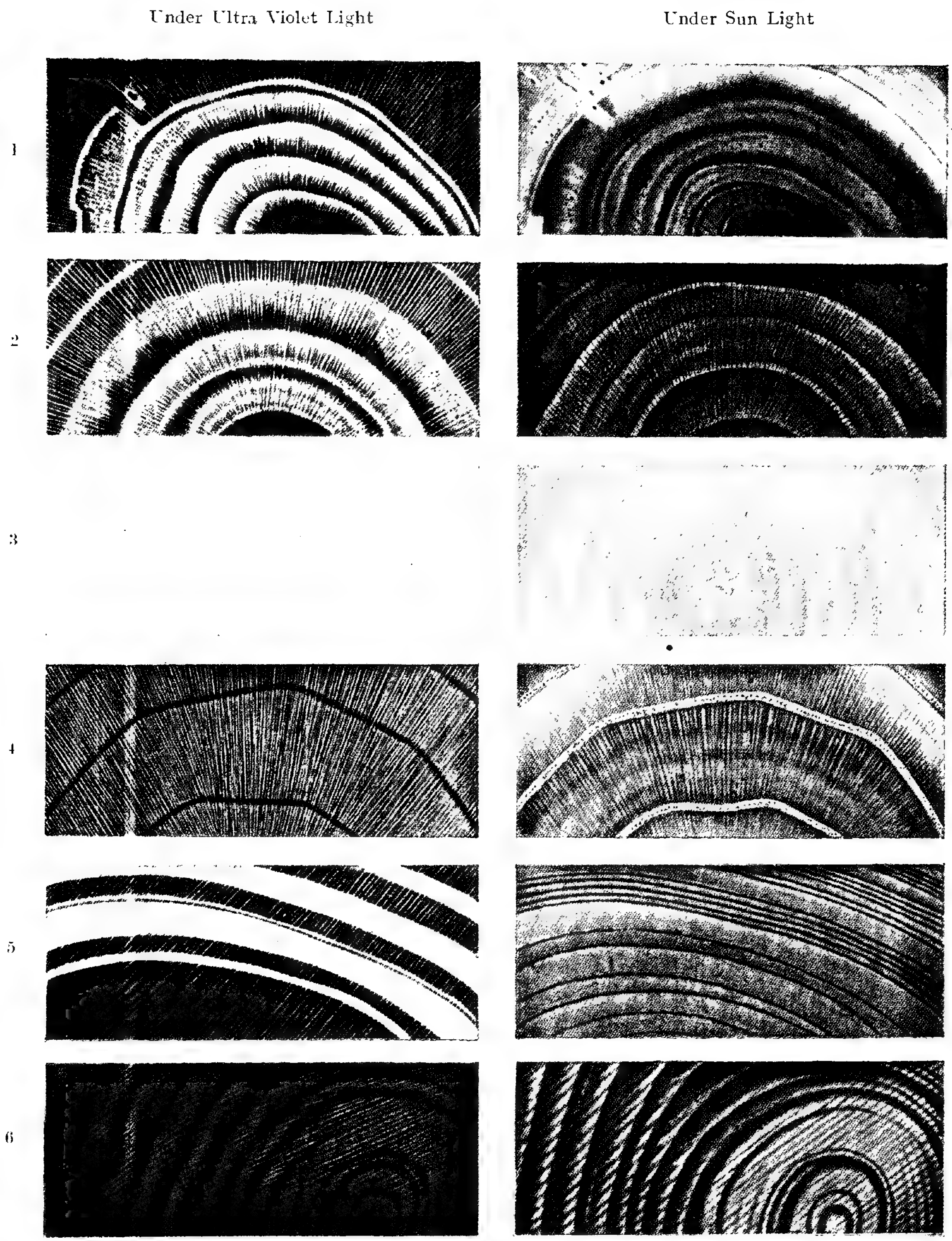
Timbers examined in connection with this investigation were authentic specimens from the collection of the Forest Research Institute, Dehra Dun. Some of these were old, having been collected about 30 or 35 years ago, while others were comparatively fresh. In the case of old specimens the surface was invariably covered with a film of oxidized matter resulting from long exposure. Fluorescence exhibited by such surfaces was not sufficiently bright. This difficulty was obviated by examining the freshly cut surfaces. The same procedure was followed in the case of blocks of both old and fresh specimens and it was a matter of satisfaction to note that there was no marked difference in intensity of the colour of fluorescence exhibited by them. In examining timbers in powder form, the samples were prepared according to the method described in the Forest Bull. No. 79, p. 7. The wood-powder (100 mesh) was spread on a clean sheet of non-fluorescent paper and exposed to ultra-violet light and the fluorescence noted. In preparing wood extracts for examination the following procedure was adopted. To half a gramme of wood powder, 10 c.c. of the solvent was added and heated to boiling. It was then cooled, stoppered and allowed to stand overnight. The extracts were filtered and viewed under ultra-violet light in glass tubes. These tubes unfortunately had a faint fluorescence of their own (dull red or dull yellow), and allowance, therefore, had to be made for this in describing the fluorescence of the extracts. The solvents used were absolute alcohol, ethyl ether, acetic acid and chloroform, and care was taken to ensure that all these were sufficiently pure and showed no fluorescence under ultra-violet light.

The ultra-violet light employed for these observations was from a " Hanovia " quartz mercury vapour lamp fitted with Wood's filter, which, as is well-known, cuts off most of the visible light and transmits the ultra-violet rays of the range 3200—3600 Ångstrom* units. The specimens, either as wood-blocks or wood-powder or extracts, were placed under these rays in a dark room and the fluorescence exhibited by them was noted. The exact representation of the shades of colour of the fluorescence was a matter of some difficulty. The

* 1 Ångstrom unit or 1 Å $=_{10}$—8 C.M.

colour of the wood block or powder, when viewed in direct sunlight, was matched against the colour-standard issued with Mullekin's "Identification of Commercial Dye-Stuff" published by John Wiley and Sons, New York. The same was not possible when the specimen was being viewed in ultra-violet light. So the nature of the fluorescence was noted in the dark room and from the impression carried, the exact colour was spotted from the colour charts and described as such. Although this method is not perfect but by repeated observations we have been able to describe the fluorescence, as precisely as possible. It has been the tendency amongst workers in this field to describe the colour of the observed fluorescence in some such vague terms as:— light blue, sky blue, milky blue, reddish violet, etc. Such terms, however, do not give a precise idea about the colour of fluorescence and much is left to the personal factor. Hence the above procedure of describing the observed fluorescence in terms of standard colours has been adopted by us, so that, by referring to the description and the colour chart, a more exact idea about the fluorescence exhibited by wood may be formed. In order to give a more ocular impression about the nature of fluorescence of wood under ultra-violet light a few coloured plates, showing the fluorescence exhibited by some species, have been appended to this note, (Plate 11).

More than a hundred specimens of Indian timbers have been examined and most of these have been found to fluoresce under ultra-violet light. The colour of the fluorescence exhibited by wood blocks and wood powder was more or less identical but, in many cases, the extracts showed a different fluorescence. Different woods showed different fluorescence, the colour ranging from snuff brown to violet with practically all shades of orange, yellow, green, blue and indigo between these extremes. Intensity of fluorescence, however, is not restricted to any particular part of the wood. In some cases, the heartwood fluoresces more brilliantly than the sapwood, and in others the reverse is the case. Then again, in many cases the colour of fluorescence in sapwood and heartwood is altogether different. In the following table, the nature of fluorescence exhibited by certain Indian timbers have been described in terms of standard colours,



Ganga Singh.

1. *Albizzia procera.* 2. *Acacia arabica.* 3. *Adina cordifolia.*
4. *Morus alba.* 5. *Cedrela toona.* 6. *Cassia fistula.*

Species.		Wood Blocks.		Powder.		Extracts.	
		Colour in sunlight.	Colour in ultra-violet light.	Colour in sunlight.	Colour in ultra-violet light.	Alcoholic in ultra-violet light.	Acetic in ultra-violet light.
Acacia arabica	S	YO (B.T.M.)	BV (B.T.L.)	OYT_2	BV (B.T.L.)	VBT_2	VBT_2
	H	O (B.T.D.)	OY	YO (B.T.L.)	OY	YG	YG
Acacia catechu	S	OYT_2	Y	YT_2	OYS_1	BV (B.T.L.)	B (B.T.L.)
	H	O (B.T.D.)	OR (B.T.D.)	YO(B.T.L.)	R (B.T.D.)	YO (B.T.L.)	YS_1
Adina cordifolia	S	YT_2	YT_1	YT_1	Y	YS_2	GS_1
	H						
Albizzia lebbek, A. procera & A. stipulata.	S	WGr	B (B.T.L.)	WGr	B (B.T.L.)	BVT_1	GY
	H	YO (B.T.D.)	OY	YO(B.T.M.)	YO	YS_1	GYT_1
Cassia fistula	S	YO (B.T.L.)	YOS_2	YO (B.T.L.)	Y (B.T.L.)	GYT_1	YS_1
	H	OR (B.T.L.)	RV	YOT_2	RV	RVT_2	BV
Cedrela toona	S	YO (B.T.L.)	Y (B.T.D.)	YO (B.T.L.)	Y (B.T.D.)	GT_1	V (B.T.M.)
	H	O (B.T.D.)	O (B.T.D.)	O (B.T.D.)	O (B.T.D.)	OYS_1	OYT_2
Morus alba	S	WGr	VT_1	WGr	RVT_1	VT_1	VBT_1
	H	Y (B.T.L.)	VT_1	OYS_1	YOS_1	BVT_1	BV

Colour standard issued along with Mullekin's "*Identification of the Commercial Dye-stuff*," John Wiley & Sons, New York.

VR—Violet-red	GY—Green-yellow	V—Violet	B. T.—Broken Tones.
OR—Orange-red	YG—Yellow-green	RV—Red-violet	L. Light
RO—Red-orange	BG—Blue-green	WGr—Whitish-grey	M. Medium.
YO—Yellow-orange	VB—Violet-blue	S_1—Shade$_1$	D. Dark
OY—Orange-yellow	BV—Blue-violet	T_1—Tone$_1$	S Sapwood
			H Heartwod.

The results obtained so far indicate that ultra-violet light excites fluorescence in wood in a striking manner. But, at the present stage of our knowledge, it is not possible to give proper interpretation of the phenomenon. There are a variety of factors which influence fluorescence in wood. Some are involved in the wood itself and the others in the light source. It has yet to be determined how far the fluorescence exhibited by wood is characteristic of the species and how far it is dependent on the age, season of collection and the locality of growth. Moreover, different parts of the tree often show different fluorescence, for instance, the sapwood and the heartwood. Excepting Vodrazka (6) who found sapwood of *Rhus* to give blue and hartwood yellowish green fluorescence, none of the previous workers seem to have paid much attention to this point. Wislicenus, for instance, merely mentions *Acacia* wood giving yellow fluorescence. This gives one the impression that both heartwood and sapwood show the same fluorescence, which however, is not the case as will be seen from the following table. The striking difference in fluorescence in some cases (*Albizzia*) makes it imperative that the two should be examined separately :—

Name.	Heartwood Blocks under U. V. L.	Sapwood Blocks under U. V. L.
Acacia catechu ..	O R (B.T.D.)	Y
,, *arabica* ..	O Y	B V (B.T.L.)
Albizzia lebbek ..	O Y	B (B.T.L.)

Of the other factors which are dependent on the light-source, the most important is the intensity of the source. There are different types of ultra-violet lamps available in these days. Some of these are of higher and the others of lower intensities. Since the intensity and the shade of fluorescence is dependent on the intensity of the incident light, it becomes necessary to state the intensity of light

employed in examining objects under ultra-violet light. The disagreement between our results and those obtained by Dalton referred to previously, may be ascribed to this factor. He employed an Argon ultra-violet glow lamp and suitable light filters and in practically all cases the woods, examined by him, showed a yellowish green fluorescence. The same species of Indian timber as were examined by him, when examined by us under a light source of greater intensity showed more vivid colours ranging from red to violet with all shades in between. It would, therefore, appear that in examining wood under ultra-violet light, light of sufficiently strong intensity should be employed.

Another important factor is the purity and the range of the ultra-violet rays employed for such studies. The ultra-violet rays, as is well known, cover a wide range extending from 136 to 4,000Å. They thus overlap the region of X-rays on the one hand, and the solar or visible region on the other. These rays are, therefore, intermediate in properties such as penetration, etc. Again each substance has its own selective wave length, which alone will excite fluorescence in it and no other. With lights of other wave lengths it may either appear dull or not respond at all. Lamps of the type of a Quartz Mercury Vapour lamp used by us emits ultra-violet rays falling within regions of both invisible and visible light and therefore special light filters had been employed to cut off most of the visible light and transmit rays of certain range of wave length. There are, however, other types of light filters available which transmit rays of a different range. Thus the fluorescence in wood described by us is restricted to the wave length of light employed. With other light filters the phenomenon would perhaps be different, very feebly visible with some and more intensified with others, and even those woods which have not shown much fluorescence with our equipment might have shown their characteristic colours.

All the above factors will, therefore, have to be taken into account in studying fluorescence of wood under ultra-violet light. Whatever work that has so far been done in this line, goes to show that, with

more systematic and thorough investigation, it might be possible to solve a variety of problems connected with wood structure, such as the identification of the wood of several Dipterocarps which are indistinguishable under the microscope.

Summary.

1. A large number of Indian woods in the form of blocks, powder, and extracts in some organic solvents, have been examined with filtered ultra-violet light of wave length 3,200—3,600Å.

2. Most of the woods show fluorescence, which in the case of certain species was very characteristic.

3. Fluorescence of wood blocks and wood powder is more or less identical but the extracts, in some cases, show a different fluorescence.

4. The fluorescence of heartwood differs from that of the sapwood in many cases and in certain species it is very marked.

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CONCERNING RAIN-GAUGES.

By W. C. Hart, D.F.O., South Kurnool, Madras.

1. The question of rain-gauges is of great importance to Forest Officers, and it is necessary that we should know something of their construction and maintenance.

2. I think we spend far too much on rain-gauges, for the prices charged for ready-made ones are out of all proportion to the cost of manufacture. I shall endeavour to explain in this note how we could make our own rain-gauges cheap, for bottles are cheap, funnels can be made by a tinsmith correctly, provided we indicate the exact size on a piece of paper, and ounce glasses can be procured anywhere, or we can make our own by means of a bottle graduated with a strip of paper, using Indian ink for the numbering and liquid shellac as the adhesive.

3. There are two types of rain-gauges in use in India, the single bottle gauge, and the differential gauge, which consists of two bottles. Each kind will be dealt with in turn.

(*a*) *The Single Bottle Rain-Gauge, otherwise called Symon's Rain-gauge.*—This is by far the simpler of the two gauges, and cheaper, as there is only one bottle to deal with, the mouth of the funnel is exactly 5 inches in diameter, and readings are taken direct in inches by means of a special " inches " graduation glass, the dimensions of which are quite different from an ounce glass.

It is very advisable to have a galvanized iron box provided with a lock, and to sink this box about 6″ into a masonry bed about 2 feet square. Also a fence is necessary around the gauge, to protect it from cattle and mischievous people.

To measure the rainfall the water in the receiver is poured into the special " inches " measuring glass, which should be placed on a level surface. Each of the graduations of the glass represents one hundredth of an inch of rain. There are 100 inch divisions. If the reading on the measuring glass is, say 47, the rainfall is ·47 of an inch, *i.e.*, 47 cents.

If only an ounce glass is available, it is useful to know that an ounce of rain corresponds to 0·089 inches or 8·9 cents. If there is more water in the receiver than the measuring glass will hold, two or more measurements must be taken and added.

These gauges are obtainable complete or in parts from the Mathematical Instrument Office, Wood Street, Calcutta, but we can make our gauges much cheaper.

(*b*) *The Differential Rain-gauge.*—This is the gauge used by the Forest Department of Madras. It contains two receivers, called the A bottle and the B bottle. The funnel of the A bottle is 3·32 inches in diameter and that of the B bottle 2·35 inches. If the superficial area of each funnel is worked out from these diameters, it will be found that the area of the mouth of A funnel is twice that of B, and receives twice the amount of rainfall. The two receivers may or may not be graduated, but it is better that they are, in ounces, to minimise chances of errors in reading. The reading is done with an ounce glass and measurements are recorded in ounces and decimals of an ounce. The object of having two bottles or receivers is to minimise the error in readings, due to evaporation, for an equal amount of water is put into each of the two bottles when the gauge is set up, and an equal amount is lost by evaporation from both bottles. Though twice the amount of rain water falls in A than in B, the evaporation from both is the same. The daily Meteorological reports throughout India are based on readings taken with the Symon's single bottle gauge, for when daily readings are taken, error due to evaporation is negligible. Our Forest Differential Rain-gauges in South India are read usually about once a month, though once a week would be better.

4. It has been mentioned above that the mouths of A and B funnels of the Differential Rain-gauge are 3·32 and 2·35 inches respectively in diameter, the superficial area of A being twice that of B. These measurements have been worked out from the single bottle gauge with its 5 inch diameter funnel and special "inches" measuring glass. Each of the A and B bottles is capable of holding about 15 inches of rainfall. Usually, exactly 10 ounces of water are put into each of the two bottles, to provide for evaporation. The calculation of rainfall is made thus—

$$\text{Rainfall in inches} = 4 \times \left(\frac{\text{ounces in A bottle minus ounces in B bottle}}{10}\right)$$

For example, if A bottle has 20 ounces, including the 10 ounces put in, B bottle which has a funnel half its superficial area should have 15 ounces, and the rainfall will be $\frac{20-15}{10} \times 4 = 2$ inches.

The tabular form used for the above particulars is reprinted below:

Set up November 1st, 1934.							Water in each receiver 10 ounces.
Date of reading.	*Water in A.*		*Water in B.*		Difference, *i.e.*, col. 3 minus col. 5.	Difference $\times 4 \div 10 =$ inches of rainfall.	Result with 10 ounces in each bottle.
	Approximate by scale.	By actual measure.	Approximate by scale.	By actual measure.			
1	2	3	4	5	6	7	8
Nov. 15th 1934.	21	20	15½	15	5	2 inches.	..

Note.—It is not generally known that a check on "fudging" can be made by observing whether column 3 minus 10=twice (column 5 minus 10). It should be so.

5. *Can we use only one of the two Differential Rain-gauge bottles for measuring rainfall?*

Yes we can, and this is how it is done.—

Suppose we have only an "A" bottle, *i.e.*, the one with the larger funnel. Then, provided readings are taken at least once a week, we can get sufficiently accurate results.

The following sample form explains :—

Approximate ounces in "A" bottle.	Exactly by measurement.	Rainfall.
4 ounces ..	3·8 ounces	$\dfrac{\frac{3\cdot8}{2}\times4}{10}=\cdot76$ inch

If a "B" bottle were used, and gave the same readings as above, the rainfall would have been $\frac{3\cdot8\times4}{10}=1\cdot52$ inches. 10 ounces of water should not be put in the bottle when only one bottle is used.

6. It seems hardly necessary for the Forest Department to use such an expensive type of rain-gauge as the 2 bottles Differential gauge. Besides, it is more complicated, both by reason of the calculations and the fact that the water in two bottles has to be measured accurately. Then again, there is that 10 ounces to be put in each bottle that may lead to errors. The man who measures the gauge is usually a Forester, who is rarely sufficiently educated to understand the theory and practice of the system. Provided readings are recorded frequently, the error due to evaporation will be negligible, when we consider that the Local Government rain-gauges, which supply rainfall statistics to the Meteorological Department, are single bottle ones, and they apply no corrective methods for evaporation.

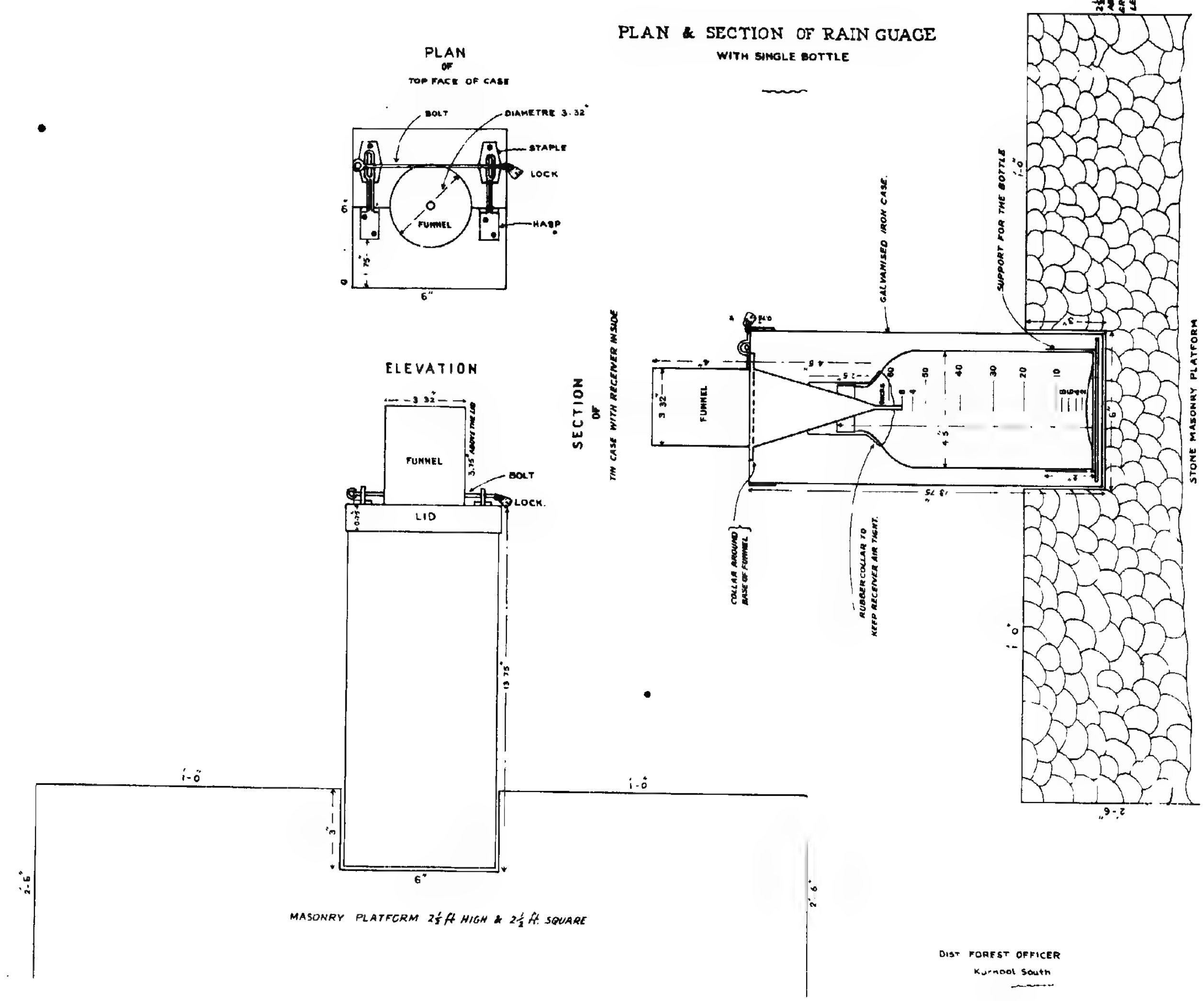
So where Differential rain-gauges are installed, and one bottle breaks or is stolen, there is no need to buy the other. Where an extra rain-gauge is needed one Differential gauge can be made into two single bottle ones. This will be real economy combined with safety.

7. *Cost of Rain-gauges.*—This is most exorbitant. A South India firm, who has supplied practically all our rain-gauges, quotes a modest sum of Rs. 47-8-0 for a 2 bottle Differential rain-gauge, and Rs. 5-8-0 for a 10-ounce measuring glass !

A single bottle Symon's rain-gauge costs about Rs. 35/- or more, with measuring glass, at the Mathematical Instrument Office, Calcutta. A one inch measuring glass alone is quoted there at Rs. 4/14/0. Incidentally, I may mention, that a Chemist at Madras has very recently quoted 14 annas as the retail price of a 10 oz. measuring glass. Compare this with Rs. 5/8/0 and Rs. 4/14/0, and gasp !

8. *Can we make our own rain-gauges ?* Certainly, and they can be substantial, accurate and very cheap. I have recently made a single bottle gauge, the plan, elevation and section of which are here illustrated. (Plate 12). To permit the use of a 10 ounce measuring glass instead of an " inches " measuring glass for one could buy the former cheap from a chemist's shop—and to enable our present Differential rain-gauge funnels to be used or the exact sizes copied, 3·32

PLAN & SECTION OF RAIN GUAGE
WITH SINGLE BOTTLE



Dist Forest Officer
Kurnool South

inches has been adopted as the diameter of the funnel. This is the standard size of the "A" bottle funnel. $3\frac{1}{3}$ inches will be quite a practical substitute.

The funnel has been made of copper with a coating of tin, but a galvanized iron one will be cheaper and serve the purpose. It looks rather elongated, projecting four inches above the top of the casing but this is necessary to prevent a splash from the top of the case.

The bottle (or receiver) can be any old thing picked up at a bottle bazaar or chemist. Wholesale chemists or the medical stores will sell them cheap. To graduate this bottle stick on to it a 1 inch strip of thin paper, using liquid shellac which is impervious to moisture. Motor dealers sell this item. Then pour several 10 ounces instalments of water in it and mark out each succeeding 10 oz. level, sub-dividing each of these 10 oz. divisions. The capacity of the bottle illustrated is 60 ounces. This will register 12 inches of rainfall, *viz.*, $\frac{\frac{60}{2}\times 4}{10}=12$ inches. If more than this rainfall is anticipated in a week, a bigger bottle can be obtained or more frequent measurements made. Symon's rain-gauges are made in sizes to register 7 inches, 15 inches and 20 inches of rain. It is possible to get a bottle holding even 100 ounces.

The outer casing has been made of galvanized iron stove enamelled on the outside. The cover of this casing hinges outwards in two halves, and when closed grips a collar on the funnel, thus keeping it pressed tightly on to the bottle and also preventing its theft, for a rod with an eyelet at one end passes through two staples in the cover and locks the whole gauge.

9. Now stand the case in a depression in a masonry platform.

A fence should be erected around the gauge of such a height and size that the top of the fence is not higher above the mouth of the gauge than half its distance from the gauge. As for the situation of the rain-gauge, a certain amount of protection from the wind is very desirable ; at the same time no obstacles such as trees or buildings should be so near to the gauge as actually to shield it from rain which may be falling at a considerable angle.

10. The cost of this single bottle rain-gauge is as follows :—

		Rs.	a.	p.
Galvanised iron sheet	.. ..	1	4	0
Copper sheet, 3½ seers	.. ..	0	14	0
One 60-ounce bottle	.. ..	1	0	0
Lock, bolts and nuts	.. ..	0	6	0
Wages for blacksmith	.. ..	3	0	0
Stone enamelling	.. ..	0	8	0
10 oz. measuring glass	.. ..	1	0	0
	Total ..	8	0	0

Is not 500 to 600 per cent. a tidy little profit to get on a rain-gauge ? And yet we have been abetting it.

TOUR JOTTINGS IN SOUTH INDIAN STATES AND COORG.

BY H. G. CHAMPION, SILVICULTURIST, F.R.I.

It is perhaps not generally realised, at least in Northern India, that the larger Indian States in the South have a professionally trained forest staff on a scale closely comparable with that maintained in British India. At the present time, the senior officers in charge of the forests are mostly familiar with Chandbagh at Dehra Dun as it was when the Provincial Service course was first opened, and have European experience as well. The following notes will refer to Mysore, Travancore and Cochin, names which probably suggest respectively sandalwood, teak plantations and forest tramways to most of us and quite rightly so, as it happens, since these particular items figure most prominently in the management of the forests and in the financial budgets. It should be mentioned that Mysore has 3,405 square miles of reserved forest, Travancore 2,397 square miles, and Cochin 580 square miles.

The immediate object of my visit to Travancore and Mysore was to see their teak plantations, and particularly the special work done recently in our all-India co-operative investigation on the effect of seed origin. It is unnecessary to go into the details of this matter,

Tectona grandis, a good quality plantation of M. E. 1054 (—1879) on alluvium, girth of near tree to left 67″ with dense evergreen undergrowth of *Leea*, *Glycosmis*, etc.
Koni, Travancore, 5th February 1934.

Saloon coach at top of the third incline on Cochin Forest Tramway, Cochin State.
Photo M. V. Laurie, 8th February 1934.

but it may be hoped that such co-operation will extend in the future to mutual benefit and to the advance of forestry. The Travancore teak plantations are, of course, well-known and have been visited and described by various officers from British India. The information about them has recently been collected by Mr. Jacob in a new Working Scheme (1933). The really important plantations, dating from the year 1042 onwards, are in three series Konni, Malayattur and Arienkavoo aggregating 2,828, 1,566 and 11,632 acres, respectively, though there are other series covering a further 2,100 acres. The first thing to remember when reading the reports is that the year 1066 is not the date of the battle of Hastings, but that of the oldest plantation in Arienkavoo, and the same as 1891 A.D. Taken as a whole, these plantations (Plate 13, fig. 1) are in excellent condition, well and evenly stocked, of good bole form and with a good undergrowth despite the practice of cutting it back at the time of thinnings. Nowadays the better species are retained and *Polyalthia cerasoides* in particular is beginning to form a nice second storey. Thinnings are done on a 5-year cycle and are saleable except the first and sometimes the second. It is particularly noteworthy that the plantations mostly take the form of narrow strips along the floating streams and are all in easy reach of a motorable cart road. The earlier plantations cost about Rs. 20/- per acre, but *taungya* methods now result in a profit of Rs. 2/8/- per acre, a figure which could be pushed higher were this not considered an unwise policy. Travancore is the home of the stumping method which has been practised almost to the exclusion of all other methods for the past 40 years. Conditions are so favourable that the nursery beds are sown late and densely to prevent the seedlings getting too big before the next planting season (2nd week of July) and early planting is also unpopular as the teak would spoil the gram crops and render the usual second partial paddy crop impossible. Lucky is the forester whose chief concern is to stop his plantations from growing too quickly ! About 140″ is the average rainfall. The oldest plantations are 67 years old, but no final fellings are contemplated at present as paddy-field teak is being worked out first as it is to lose its status as a royal tree.

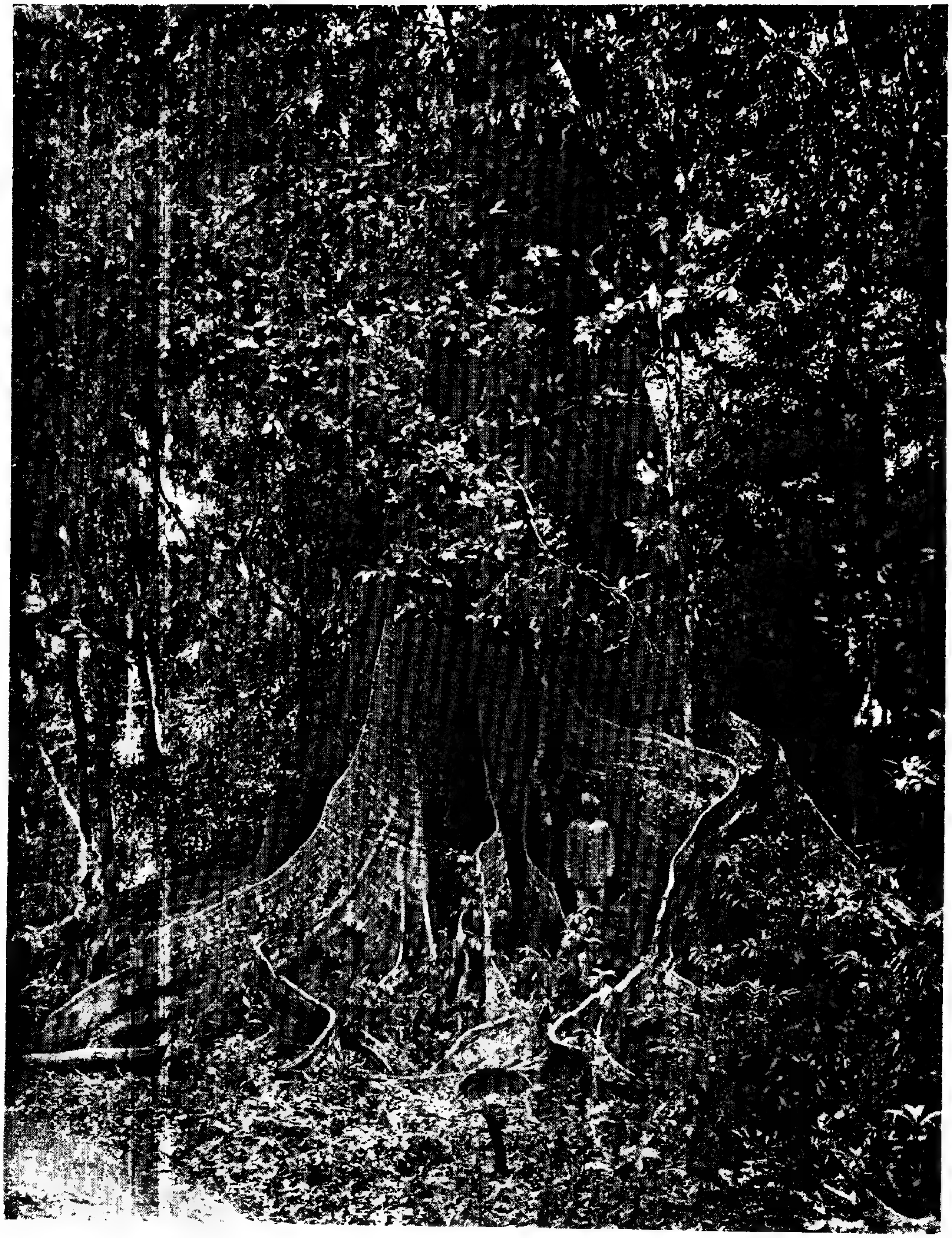
My companion (the Madras Silviculturist, Mr. M. V. Laurie) and I had every reason to be grateful for the hospitality extended us by the State and the efficient arrangements made by the staff which enabled us to fit in a very full programme with a maximum of comfort. We shall long remember the little "inspection huts"—even though only one or two of them contain chairs with Vi-spring upholstery—the excellent roads, and the light refreshments spread for our party in the jungle, reminding us of student days in the French forests.

The Conservator of Forests, Cochin, had accompanied us in Travancore and when we were invited to return to Mount Stuart *via* the famous Cochin forest tramway, we were glad that we could fit it in. I can confidently say there is nothing like it in India, nor have I met its equal abroad (Plate 13, fig 2). Justice could not possibly be done to it in the few paragraphs at my disposal and I can only recommend anyone who has the chance not to miss it ; the rush in the saloon up the 1 in 3 incline with the counterpoise, a huge log, charging down past you—at least you hope you will get past safely—is particularly thrilling. Once more, State hospitality was most liberal.

Cochin, too, has its teak plantations including some 800 acres prior to 1872 in the vicinity of the tramway ; these will be coming into bearing before the outturn from the natural forests falls off seriously. This tramway dates back to 1907 and can claim to have averaged a net profit of Rs. ½ lakh annually after allowing 2 per cent. on capital, and I hope one day to see an illustrated account of it in the pages of the *Indian Forester*.

Mysore, like Madras, has to deal with a very wide range of forest types from rich tropical evergreen to dry thorn scrub. Teak plantations have been made in the State on a quite extensive scale and over a long period. Conditions are very much less favourable than in Travancore, and naturally the results are not so good, but good work has been done and some of the plantations have already proved a paying proposition.

Stump planting is the customary method. *Taungya* methods have not yet proved practicable on any large scale, so that all work



Elaeocarpus tuberculatus with plank buttresses extending 20 feet up the stem.
Agumbe, Shimoga Division, Mysore, 11th March 1934.

has to be paid for. Costs have been as high as Rs. 60/- per acre, but stand now at about Rs. 25/-. Improvements in technique may be anticipated in the near future as there is no shortage in keenness.

The evergreen forest management problems have not really been taken up in Mysore yet (Plate 14). The most interesting thing seen was the extraction of the large transmission poles of *Poeciloneuron indicum* which are taken to Bhadravati and creosoted before use.

I saw very little of the sandal bearing forests, though I made an interesting visit to the distillery at Mysore. Actually, there is practically no green sandal being felled at present owing to the depressed market, over production, and the need of utilising spike disease killed stock. The investigations aiming at clearing up the mysteries surrounding the nature of spike disease and its spread constitute one of most important pieces of forestry research work in progress at present and are of absorbing interest. We were fortunate enough to be able to learn at first-hand of the experimental work at both Bangalore and near Hosur, and were very struck with the keenness and care with which it was being done : a research worker could not ask for a more fascinating subject to study and we came away with a feeling that it would be almost a pity when the mysteries are finally unveiled. One investigator was blaming himself for going home from watching his pets in the forest at 2 A.M., as later indications were that they were taken ill between then and dawn in his absence !

Liability to spike is of course a very important consideration in any sandal propagation scheme, which latter figures rather importantly in Coorg's forest programme. Coorg again has its rain forests and its dry ones, but it is to the latter that it looks for much of its revenue. Experience has taught that sandal plantations can make a good showing in their early years but have a way of not living up to their early promise, and the reasons are being actively sought—the spike disease is not the only baffling thing about the species, and the parasitic mode of growth introduces a series of complications in plantation and tending technique beyond what are encountered with, say, teak. Here is a great field for carefully planned forest research.

Mention of teak reminds one that Coorg, too, has planted and is planting a good deal of teak. The special feature of the Coorg teak practice is burning over the one season old plantation, which I have only seen being done years ago in Upper Burma. It is claimed that there is less weed growth in the second season and that the teak shoots are better than they would be without it. Actually the claim has not been substantiated by acceptable comparative experiments though these are now being made. My forecast is that a small difference in favour of the burning may be found, but that the future will see an improvement in first year results and with such improvement, the burn will be found detrimental.

There is not much being done in the Coorg evergreen forests at present, though limited sales of certain species can still be effected. It was interesting to visit the older Makut coupes once more though inspection of the regrowth after heavy fellings is neither easy nor cool work. Good patches of regeneration are certainly obtainable but it is impossible to form any idea of the position as a whole from a rapid inspection such as we were able to make. Coorg is going to start a small Forest Research branch which should be a very sound investment. Close co-operation with Madras is planned and, in my opinion, is essential for efficient functioning. Might not Mysore and Travancore emulate Coorg's example and make the prosecution of research one officer's first responsibility ?

THE MESQUITE IN THE PUNJAB.

By R. N. Parker, I.F.S.

As the cultivation of the *mesquite* in the Punjab is receiving a good deal of attention at the present time it may be of interest to record the origin of the various forms in cultivation.

Up to 1912 there was only one form, the deciduous *Prosopis glandulosa* in cultivation in Lahore. Now there are 5 more or less recognizable forms which are evergreen or semi-evergreen. By semi-evergreen forms I mean those which have no autumn leaf-coloration followed by shedding of the leaves. Instead the foliage becomes

thinner and thinner until by the end of January perhaps the tree may be quite leafless. When this has happened it is naturally not possible to distinguish between the deciduous and semi-evergreen forms.

In 1912 two forms were obtained from Garten-inspektor Purpus of the Botanic Gardens, Darmstadt. The seed was collected for us by special request in Mexico by his brother who toured extensively in Mexico collecting plants and seeds. These may be called :—

The Arid Country Form.—This was described as a tree growing in an exceptionally arid district of Mexico. Three plants only were raised and were planted in the Forest Office Compound in Lahore. Two still survive, the best being 33 feet high and 3 feet 1 inch girth at 22 years old. Seed from this has been distributed and there are 2 or 3 specimens in the Government Agri-Horticultural Gardens, Lahore.

When young the crown consists of a dense mass of twigs, more or less tangled, which hide the main stem. As the plant becomes taller the stem below becomes clear of branches. The leaves are more or less evergreen with usually one pair of pinnæ and leaflets $\frac{1}{3}$ inch long.

The Mexican Tree Form.—This was described as a tree 20 m. high and 2 m. girth. Only one plant was raised and it still exists in the Forest Office Compound, Lahore. It is now 22 years old, 35 feet high and 4 feet girth. Many seedlings were raised from this tree in 1915—17 and several still survive. They vary very considerably in habit and in the extent to which they retain their foliage. Some are distinctly evergreen, but most are better described as semi-evergreen. Some of the latter can scarcely be distinguished from *P. glandulosa*. One specimen has reached a height of nearly 60 feet, others are only 20—25 feet high. The leaves have usually one pair of pinnæ but two pairs are not uncommon and the leaflets are about $\frac{3}{4}$ inch long.

To this form a second introduction may also be referred. It was obtained from a correspondent in the State of Sonora, Mexico, about

1916, in exchange for seeds of *kikar* and *sissoo*. A considerable number of seedlings were raised and they are quite uniform in appearance. This Sonoran form is more evergreen than most of the Mexican tree forms. It reaches a height of about 30 feet and has markedly arching branches. The leaves have, as a rule, 2 pairs of pinnæ with leaflets about ½ inch long.

About 1915 three more forms were introduced which may be called :—

The Australian Form.—This was obtained from Australia in exchanges by the Government Agri-Horticultural Gardens, Lahore. Shortly after it had been received from Australia it was found growing in Kapurthala having been obtained from the Botanic Gardens, Saharanpur. It is, I believe, the form of *Prosopis juliflora* which is naturalized in the Sandwich and Philippine Islands. It is an erect tree reaching about 25 feet in height and has reached a girth of 3 feet 10 inches in 19 years in the Forest Office Compound. It fruits freely twice a year, once in the hot weather and again at the beginning of the cold weather. As the seed is thus very readily collected this form has been more distributed than any other. The branches are mostly straight and horizontal with a slight downward inclination. The leaves have usually two pairs of pinnæ with leaflets ⅓ to ½ inch long.

The Peruvian Form.—This was obtained from the British Consul in Peru in 1915. A few plants were planted in the Forest Office Compound but most of them were given to the Government Agri-Horticultural Gardens. It is an erect tree reaching 35 feet or more and has much the habit of *Acacia arabica* for which it can easily be mistaken at a little distance. The leaves have 2—4 pairs of pinnæ with about 12 pairs of rather small leaflets.

The Argentine Form.—This was obtained about 1916 from Buenos Aires in exchange by the Government Agri-Horticultural Gardens, Lahore. The same form has since been obtained from Uruguay. It is an erect form reaching a height of 20—25 feet. It is semi-evergreen usually becoming quite leafless for a short time or for 2 months before the fresh foliage appears. The leaves have, as a rule, 3 pairs of pinnæ with 40 pairs of close-set narrow-oblong leaflets.

All these forms have been seen regenerating naturally in the Punjab so conditions evidently suit them. Although generally considered one species they are clearly not identical and for cultural purposes it is necessary to distinguish them. The Argentine form is the most readily distinguished but it is placed with others as *Prosopis juliflora* in the Kew herbarium. The separation of the forms is rendered more difficult by not knowing how many to distinguish. The Mexican tree form appears to be a hybrid and not a pure line. In India it appears that these forms hybridize freely. If one assumes that the pod characters of the Mexican tree form are recessive, we appear to have hybrids of the Mexican tree and Argentine forms and of the Mexican (Sonoran) tree and Australian forms. As a result of this it is often not possible to distinguish the various forms and the difficulty of doing so is likely to increase as time goes on. At the same time it is essential not to treat all these forms as being one and the same thing so that efforts are being made to establish small plantations of the various forms to serve as sources of seed if needed in the future.

One of the most important differences in the cultural requirements of the various forms of mesquite is their response to frost. The Argentine, Arid and Mexican tree forms appear to be quite frost-hardy anywhere in the plains of the Punjab. The Australian form is sensitive to frost, when young. In the winter of 1933-34 a line of this form grown as a hedge was killed to the ground by frost in the Rawalpindi district and a fairly large specimen in the Pabbi hills was badly injured by frost. In the winter of 1934-35 it was frozen to the ground in Khanewal, Chichawatni, Miranpur and other places where tried. This form seems to be about as frost-tender as *Acacia arabica* and although it can be grown as isolated individuals or in narrow strips, it is clearly too sensitive for plantation purposes west of the Beas. There has been one peculiarity about this form and that is that wherever it has been tried a certain number of plants have escaped injury. In patch sowings it is common to find one plant in a patch has escaped injury, whereas the others have been frozen to the ground. The most probable explanation of this seems to be that the plants that have

escaped frost injury are hybrids, probably with the Mexican tree form as the other parent. The Peruvian form is rather more sensitive to frost than the Australian. In Changa Manga large specimens were killed almost to the ground in the winter of 1928-29. Near Peshawar it appears to be frozen down regularly every winter.

Apart from frost, we know little as yet as to the requirements of the various forms. There is some evidence that the Arid country form does better than the Australian under very dry conditions. Also the Mexican tree form regenerates fairly freely under favourable conditions on the Ridge at Delhi, whereas the Australian form does not. From this it may be inferred that the former is better suited to shallow rocky soil than the latter. The Australian form is clearly the one to choose if the pods are required as fodder as it produces two crops a year, one about May, the other in November. As a road-side tree for arid country the Peruvian form is the one to select in places free from frost or nearly so. For forest plantations one of the frost-hardy forms must be used. In all cases it is advisable to select the seed from well-grown specimens of satisfactory habit so that the less desirable forms may be eliminated as far as possible. For afforestation purposes any trees which regenerate specially freely should be favoured as sources of seed for further sowing under similar conditions.

SCOTTISH FORESTRY SOCIETY EXCURSION.

By R. Maclagan Gorrie, d.sc., I. F. S.

The choice of Southern Perthshire as the field of operations for the 1934 excursion was based on a number of arguments. The chief points were:—ease of access and small railway fare which might encourage a large attendance in these hard times; a number of small estates whose management would interest the smaller landowners and officials of local bodies such as town councils; and a favourable opportunity of studying the growing of hardwoods, an art which at present is apt to be neglected, owing to the general preference for fast-growing conifers. Outside of technical forestry the area around Dunblane is one of very great historical interest for almost every field has some

association with early British stone circles, Roman camps and roads, Wallace's and Bruce's innumerable battlefields, Mary Queen of Scots' sheltered girlhood and troubled reign, the two Stuart campaigns and in fact of every phase of Scottish history, besides the less historic but perhaps more vivid memories of the outlawed Rob Roy MacGregor and countless clan forays across the rich lands of the Forth valley. With comfortable quarters in Dunblane-Hydro and a very efficient service of motor buses, we managed to cover a very large amount of ground.

The excursion programme of four days, 5th to 8th June, gave us two days in the lowlands of the Forth valley in the immediate neighbourhood of Stirling, and two days in the more mountainous moorland country to the north, with itineraries which took us round the very beautiful areas of Callendar, Loch Lubnaig, Loch Earn and Loch Katrine. Most of the areas visited were privately-owned estates, but plantations made by the Forestry Commission and by a city corporation were also examined.

Hardwood cultivation.

The main intention of this excursion was to indicate the possibility of growing hardwoods in Scotland and the area was excellent in this respect, as we were able to examine some of the deep "carse" lands of the Forth basin, possibly some of the richest soils on which British woodlands are found to-day, alongside the poorer soil of the Campsie and Ochil hill slopes.

In Gargunnock on the northern slopes of the Campsies, 5 miles west of Stirling, there are some 180 acres of plantations, most of which have been felled and replanted during the last 45 years, so that only a few patches of older woods remain. Below the 500-foot contour sycamore is practically a weed and has to be cut back in the conifer and oak plantations. Oak, on the other hand, is backward in its early stages, needs a lot of attention and takes a great many years to produce saleable timber on anything but deep carse-land soil, so that it is an expensive timber to produce. Its value as a windfirm species in the shelter belts on the higher slopes has however been amply demonstrated. Some good stands of middle-aged and almost mature

oak and Norway spruce were examined, showing that for the lower slopes this makes a well-balanced mixture, though the spruce is apt to be suppressed eventually except along the edges of the belt. Where the naturally grown sycamore has been encouraged in groups and pruned it looked splendid and was far ahead of oak of the same age. In view of a steady local market for rollers, etc., it seems a pity that greater advantage is not taken of the sycamore's profuse natural regeneration. Another hardwood stand to be visited was at Rednock on the sandy knolls along the shore of the Lake of Menteith. Here the soil is a deep glacial gravel, and the oak is of a better type.

In the Wood of Drummond, 3 miles south of Crieff, we had an all too brief glimpse of old natural oak forest,—one of the few remaining examples of this type of woodland growing on the deep carse-land soil which so eminently suits it, but from which it has everywhere been driven out to make room for agriculture. In spite of fairly frequent and heavy fellings amongst the best oak stems enough is still left to show what very fine oak can be produced from such a soil.

A further opportunity to study hardwood forest was given at Airthrey and Abbey Craig, both adjoining the city of Stirling. Both of these sites are on steep slopes of glacial *débris* accumulated against rocky hills, yielding dark fertile loams pre-eminently suited for ash and sycamore on the moister sites and oak on the drier ones. Sycamore is so obviously at home that it has to be continually cut back if other more valuable species are to get through at all. This pure sycamore type is marked by a soil flora of almost pure *Mercurialis perennis* and in spite of many attempts to introduce conifers, only an occasional *Wellingtonia* and European larch has got through to maturity and neither species seems quite at home.

The history of the Abbey Craig Wood is better known than the Airthrey one. It is on a slope of glacial *débris* rising steeply up to 350 feet above sea level. Planted 90 years ago, with a thorough mixture of various hardwoods and conifers, the wood has escaped maltreatment of any kind, and it shows very clearly what species are suited to such a site. Of the conifers only a few mediocre larch remain, and the oak tends to oust the sycamore on the drier sections. The

regeneration of this wood is being undertaken very gradually by the Burgh Authorities of Stirling who wisely wish to keep this valuable woodland as nearly as possible in its natural state. When open spaces occur they are netted against rabbits and replanted and it was suggested that these netted areas should not be entirely planted up with Douglas fir as at present ; the Douglas is after all a foreigner and not so suitable for this site as the indigenous hardwoods such as oak, ash, beech and elm, which with a little care could be nursed up along with the very plentiful natural regeneration of sycamore. If evergreens are needed for amenity, beech and holly and an occasional *Abies grandis* or *A. nobilis* would be preferable to Douglas.

At Keir Estate near Bridge of Allan Mr. Stirling and his head forester, Mr. McEwan, showed us what was undoubtedly the best piece of scientific silviculture seen during the week. The treatment of the young oak on the rolling ground along the edge of the carse is obviously most successful and is based upon a close attention to the individual requirements of the oak through the various stages of growth. The planting distance is 3′ by 3′ and the mixture is in the proportion of 25 beech to 15 oak and 8 European larch. Every third row is composed of beech and larch alternately, the other rows consisting of beech and oak alternately so that the larch nurses stand 6′ by 9′ apart. Two-year seedlings of oak rather than larger transplants are preferred for planting and they may be put in a year or two ahead of the nurse species. As the oak comes up it is protected by cutting the beech branches back fairly heavily, so that the oak is always a little ahead of its neighbours. The larch is allowed to go ahead as it is found that at this spacing its side shade is in no way dangerous, in fact its being some feet ahead in height serves to pull the oak after it and encourages height growth in the oak. The larch is pruned at about 7 or 8 years, as soon as it shows signs of interfering with the oak, and it can usually be kept until about the twelfth year when it is marketable as fencing or small mine timber. The danger of neglect in later stages was well shown in stands near Gallowhill where larch and sycamore nurses had been allowed to suppress the oak pole crop completely.

In the official debate at the evening meeting on 7th June, the President, Mr. J. H. Milne Home, focussed the discussion on the importance of hardwoods in Scotland and paid a tribute to Colonel Stirling of Keir, to whose genius in forestry were largely due the very excellent results achieved at Keir. He then called upon the convener of the excursion for his views. Dr. Mark Anderson said that he was in favour of maintaining and extending hardwoods and encouraging the natural regeneration of hardwoods in those areas already under such crops. There are many thousands of acres in Scotland suitable for such crops. He advocated the more extended use of conifer nurses which would secure early money returns. From the point of view of small landowners he pointed out that the advantages of a hardwood mixture lay in the very definite soil improvement obtained, the reduction in fire and wind damage, the improvement in the aesthetic value of the woodlands particularly in the neighbourhood of towns, the attraction to wild life and the consequent improvement in the game value of the plantations. He pointed out that there would always be a certain market for hardwoods from areas adjoining arable land for many of the smaller requirements such as tool handles. He asked the smaller landowners to consider carefully the ultimate effect of the Forestry Commission's present activities in planting great areas of conifers which will be liable to flood the softwood market, but leave the hardwood market untouched; poor quality softwood cannot fetch the prices likely to be obtained for the good quality softwoods of the large-scale Commission plantings, whereas small lots of even mediocre hardwoods will meet less competition and will be easier to market. In many places inferior conifers were being produced on what was really hardwood land but the value of good hardwoods per unit volume is undoubtedly better than that of poor conifers. The difficulties in marketing would, he hoped, be overcome by obtaining a reduction of the present heavy taxes on hardwood areas, but the quality of the seed supply and the technique of establishment and tending would have to be improved.

Several other members spoke, and opinion was sharply divided, some of the landowners themselves indicating that they considered

hardwoods and particularly long rotation crops should be left to the Forestry Commission to grow. The President in closing the discussion pointed out that the Forestry Commission had not neglected the growing of hardwoods but had arrived at their policy of restricting hardwood planting to only the very best areas after very careful consideration. He agreed that it was most necessary for landowners to co-operate in obtaining skilled help and for all growers of timber to co-operate in its marketing.

Conifer Plantations.

Gartmore some miles further west near Aberfoyle had some interesting examples of conifer mixtures. Where Japanese larch and Douglas fir had been planted as alternate trees at 3 feet distance on fairly deep glacial clay, the Douglas is suppressing the larch and will eventually become pure. On the other hand, in a Japanese larch and Norway spruce mixture the larch is now almost pure and well spaced, though our impression was that the commencement of thinnings in all the plantations had been much too long delayed. This was particularly evident in a wood where oak now of marketable size had been underplanted with Douglas which is now very spindly and must obviously be damaged whenever any of the old oak are removed.

The Ardchullary Woods on the slopes above Loch Lubnaig extend to 260 acres, all planted by the late General Archibald Stirling between the year 1892 and 1928. They are entirely of conifers, although the local natural woodland type, which was well seen while motoring up the Pass of Leny, consists of scrub oak and birch with alder and ash in the valley bottoms. Most of the popular conifers have been used but the bulk of the plantations are of larch, the Japanese being definitely superior to the European, as the latter is badly cankered on all except the very best sites. The planting distance was 3 feet × 3 feet until 1917 after which it was increased.

While motoring from Ardchullary towards Loch Earn we saw by the roadside some groups of fine old Scots pine at Immervoulin, Strathyre, which have recently been rescued from a timber merchant's axe by the Forestry Commissioners. The felling of these old woods had caused much public indignation, which was directed against the

Forestry Commission although actually the timber on the estate had been purchased by a timber firm at the same time as the Forestry Commission had bought the land for replanting. To meet the difficulty the Forestry Commission have very wisely bought back some 80 of the standing trees forming groups along the roadside and have thus saved them from the axe, thus earning the gratitude of the Association for the Preservation of Rural Scotland, which had taken the matter up. A further group of really splendid old European larch was next examined at Ardvorlich on the south shore of Loch Earn ; there are 13 of those old giants left, planted about 1788 and now averaging 120 feet in height and varying from 8 to 14 feet in girth. They form an inspiring example of what can be done by planting the right tree in the right place and they were of particular interest to Herr Anton Smitt, a Norwegian Forest Research Officer, who had been sent to this excursion as a delegate of the Norwegian Forestry Society, chiefly to study the question of the origin of seed of larch and some other conifers.

At Cromlix on the higher ground 3 miles north of Dunblane we saw some excellent examples of what can be produced in the way of shelter belts for stock or even the most exposed moorlands. Relatively slow growing Sitka spruce planted in 1911 had formed a dense belt and is still putting on good height growth. Younger belts of Norway spruce and of mixed Norway spruce and Scots pine have been recently pruned and form excellent shelter. Further shelter-belts on slightly less exposed ground were visited on the Glassingall estate where Douglas and Sitka have been notch planted. The examples of the different types of Douglas seen here and elsewhere during the tour showed that certain of the slower growing varieties of Douglas from the interior of Canada are definitely less subject to *Chermes* attack than trees of quicker growth from coastal districts. Little, however, is known of the origin of seed beyond the fact that the seedlings were obtained from such and such a local nurseryman and it is obvious that we ought to have more definite information about whatever Douglas seed is imported into Scotland.

Our last day's visit to the City of Glasgow Corporation's catchment area proved to be the most interesting of all for conifer growers. The north shores of Loch Katrine, with the exception of a few broad gaps running uphill to allow free access for sheep to the high pastures, are being planted up, and since 1923 some 800 acres out of a total plantable area of just over 5,000 acres have been dealt with. The soil is schisty loam which is usually fairly well drained, but with a rainfall of from 68 to 93 inches it tends to be marshy on the gentler slopes; there is also peat along the higher limit of planting which is here about 950 feet. A heavy bracken crop has been troublesome, and when this was successfully cut back, grass growth often smothered the young plants. In the 1923—1926 plantings a large percentage of Norway spruce, European larch and Scots pine was used and very little Sitka, for in those years its seed was very expensive. Latterly, a much larger percentage of Sitka up to 50 per cent. of the total has been used and it is growing exceedingly well, though the Norway spruce is still considered by Mr. John Munro, who has been head forester since these operations started, to be the most suitable for heavy ground.

An interesting point illustrating how the creation of new forests alters the local fauna was that bullfinches, previously most uncommon in this district, now swarm in such numbers as seriously to affect the health of the larch, from whose tips they strip the buds. The method of planting in the Loch Katrine work has been by L notch on upturned turf at a spacing of 4½ feet. The discussion here turned upon old records of turf planting which is so often and erroneously thought to be a new Belgian importation; there are records to show that turf planting was introduced to Ireland over 100 years ago by Scots foresters and that even further back it was in use at Douglas 160 years ago.

The chief points about conifer culture brought out at this excursion can be summarised as under :—

1. Grow more mature Scots pine, which is still Scotland's best general purposes timber, rather than exotics which have not yet been fully tested.

2. Select Douglas seed from areas in Western America which are as near as possible climatically to the area to be planted. Plants from unsuitable seed zones will assuredly be attacked by *Chermes*.

3. Don't neglect Norway spruce entirely in favour of Sitka. In certain heavy ground Norway spruce is still the better species.

4. Maintain a small percentage of hardwoods in all shelter-belts as this undoubtedly makes them more windfirm.

BOXWOOD BORERS (HETEROBOSTRYCHUS).

BY C. F. C. BEESON, FOREST ENTOMOLOGIST, F. R. I.

Damage by borers or "worminess" in packing cases, tea-boxes, plywood, etc., and in timbers used for similar classes of work in India is due to several species of beetles. The habits of these species are dissimilar and the rates and modes of development of the damage due to them are not uniform. The liability of each species of timber to damage also varies with each species of borer.

If worminess were everywhere due to one kind of insect the problem of protection would be simplified and a standard set of rules could be devised for universal application. Under existing conditions practically every sawmill, factory or storage depot requires a special prescription, which must be preceded by an authoritative determination of the borer or borers involved.

This article deals with the habits of beetles of the genus *Heterobostrychus* (family Bostrychidæ) and their allies. A previous note covered the group of *Lyctus* beetles (*Indian Forester*, LIX, 1933, pp. 158-164). Other bostrychid beetles of the genus *Sinoxylon*, and the longicorn borer of drywood, *Stromatium barbatum*, will be dealt with later.

Heterobostrychus beetles are black, cylindrical insects with a rough, hooded prothorax and usually curved hooks or projections at the hind end of the elytra; the body length is 6 to 15 mm. The female is different in build to the male which occurs in two or more forms. It is not possible to give characters for differentiating these beetles without

citing morphological details. The larvæ are described and figured by Gardner in *Indian Forest Records,* XVIII, IX (1933). The species found in India are *Heterobostrychus æqualis* Waterh., *H. hamatipennis* Lesne, *H. pileatus* Lesne and *H. unicornis* Waterh.

HETEROBOSTRYCHUS ÆQUALIS.

This borer occurs throughout India, Burma and Ceylon, and is the commonest of the four species. It has been recorded from *Adina cordifolia, Anisoptera glabra, Bambusa arundinacea, Bombax malabaricum, Canarium euphyllum, Dendrocalamus strictus, Dipterocarpus pilosus. D. turbinatus, Endospermum chinense, Kydia calycina, Lannea grandis. Leucæna glauca, Mangifera indica, Parashorea stellata, Parishia insignis, Poinciana elata, Pterocarpus indicus, Quercus* sp., *Shorea leprosula, S. robusta, Sterculia alata, S. campanulata, Terminalia belerica. T. bialata,* and *T. myriocarpa* and no doubt attacks other timbers.

The female beetle may lay eggs on the rough surfaces of sawn timber and of barked logs, or in natural cracks and holes, or may bore short tunnels into the wood for the purpose of feeding and oviposition. The larval tunnel, which starts from the spot where the egg is deposited and gradually widens, may reach a length of 10 to 12 inches and a diameter of a quarter of an inch. It is generally much convoluted, changing direction and intersecting other larval tunnels, and is tightly packed with fine powdery wood-dust—the undigested residue of the wood excavated and eaten by the larva. The presence of a filling of powdery wood-dust distinguishes the work of *Heterobostrychus* from that of pinhole and shothole borers which are also pests of box planking and plywood, but which make tunnels clean of wood-dust and stained black within. The greater length and diameter distinguishes a *Heterobostrychus* tunnel from those of the smaller *Lyctus* larvæ.

After the full grown larva has pupated in a cell at the end of the tunnel it turns to a beetle, but the latter remains for a variable period within the wood towards the end of which it is occupied in further boring and feeding, finally emerging by an exit-hole at the surface.

The emergence of the beetles takes place during the monsoon season—June to October. From material caged in the Dehra Dun

Insectary it has been ascertained that swarming reaches its maximum abundance in July when about 45 per cent. of the beetle population of the year emerges. In the remaining eight months not more than 7 per cent. leave the wood.

The life-cycle from egg to swarming beetle requires a minimum time of one year, but it is usual for a large fraction of the larvæ resulting from eggs laid at one season to take two or three years to complete development. The longest period recorded for the life-cycle is five years (in plywood) and six years (in opium chests of *semul*).

When barked logs are heavily attacked by *H. æqualis* the wood is reduced to powder to a depth of two or three inches except for a residual skeleton or network. In soft woods the damage may extend deeper; in hard woods with a well marked heart the penetration is confined to the sapwood. In planks attacked after conversion the larvæ are forced to extend their tunnels in the plane of the plank. In plywood panels the tunnels are confined to one sheet of ply by the intervening glued layer, which is not penetrated by the larva; hence damage in plywood is limited to the adjacent outer faces of panels in contact, until the beetle bores out to escape. Emerging beetles will bore through a thickness of one or two inches, and will also make holes through the lead foil of tea-boxes.

HETEROBOSTRYCHUS HAMATIPENNIS.

This species occurs throughout India, Burma, Indo-China and Ceylon and is known to attack *Acacia catechu*, *Anogeissus latifolia*, *Bombax malabaricum*, *Boswellia serrata*, *Canarium strictum*, *Dalbergia sissoo*, *Dendrocalamus strictus*, *Machilus* sp., *Mallotus philippinensis*, *Mangifera indica* and *Shorea robusta*.

Its life-cycle is similar to that of *H. æqualis* requiring a minimum period of one year with emergence mainly in June-July. The longest recorded period before emergence is two years.

HETEROBOSTRYCHUS PILEATUS.

This species is a forest inhabiting species rather than a depot and warehouse pest. It occurs throughout British India and Indo-China. The recorded foodplants include *Acacia pennata*, *Cassia fistula*, *Garuga*

pinnata, Lannea grandis, Mallotus philippinensis, Mangifera indica, Pavetta indica, Santalum album, Sindora siamensis, Shorea robusta and *Zizyphus* sp.

Its life-cycle is annual but it emerges earlier than the preceding species, swarming in April and May, over 70 per cent. emerging in April.

HETEROBOSTRYCHUS UNICORNIS.

Is a rare species known only from *Butea frondosa* and *Shorea robusta*.

Closely allied to *Heterobostrychus* in appearance and habits are *Bostrychopsis bengalensis* Lesne, *B. parallela* Lesne and *Schistoceros anobioides* Waterh.

BOSTRYCHOPSIS PARALLELA.

The black cylindrical beetle is about 10 mm. long; the larva is described and figured by Gardner in *Ind. For. Rec.*, XVIII. IX, p. 14, pl. IV. The species occurs throughout India, Indo-China and Malaya as a borer of dry *Bambusa arundinacea*, and *Dendrocalamus strictus* especially of large dimensions used for tent poles and army telegraph poles. The life-cycle in *D. strictus* is annual but is frequently prolonged for two or three years. The longest recorded cycle is six years in bamboo tent poles stored in military arsenals. The main emergence takes place between the beginning of June and the end of September, with 40 per cent. of the annual population emerging in July. A small percentage of beetles matures at other periods of the year.

It has occasionally been found boring softwoods in India and dipterocarps in the Philippines but this appears to be an abnormal habit.

BOSTRYCHOPSIS BENGALENSIS.

Is a much rarer species also boring bamboo tent poles and emerging in June-July.

SCHISTOCEROS ANOBIOIDES.

The beetle is on the average larger than the foregoing species, 12 to 18 mm. long; the larva is described and figured in *Ind. For. Rec.*, XVIII. IX, p. 13, pl. IV. The species occurs throughout the

Indian region as a borer of poles and the sapwood of logs of *Anogeissus pendula, Bombax malabaricum, Buchanania latifolia, Dalbergia paniculata, Garugapinnata, Holarrhena antidysenterica, Lannea grandis, Mallotus philippinensis, Psidium guava, Shorea assamica, S. robusta, Tectona grandis* and unidentified woods used for army tent pins.

The life-cycle is ordinarily annual but occasionally, as for example in wooden tent pins alternately exposed to the weather and stored in the dry, the life-cycle may last three years. Emergence occurs mainly between March and July with 30 per cent. of the population emerging in May and 20 per cent. in June.

CONTROL OF HETEROBOSTRYCHUS, ETC.

The most effective means of protecting logs lies in early extraction and conversion. In the case of trees felled between November and April the liability to attack is relatively small. Those felled at the end of the hot weather and during the rains should be extracted and converted with as little delay as possible, with the exception that logs extracted by floating are safe so long as submerged in water.

It should be possible to keep sawmills, factories or storage depots in any locality practically free from borers by frequent inspection of stock and by burning or disposal of infested pieces. One regular inspection a year, preferably during the cold weather, is the least that is advisable. When this is done it is evident that no production of borers can take place on the mill or factory premises, and the external sources of danger are counteracted by the same preventive measures. The very small proportion of stock that may have to be destroyed by this practice represents a loss much less than the expenditure entailed by treatment with antiseptics. In very bad localities an additional precaution would be given by distributing freshly cut waste of *semul* or mango in July to act as baits or traps to stray beetles, and burning these pieces in December.

Plywood made up from infested logs is automatically sterilised during the processes of peeling and glueing; hence damage does not carry over from the log to the panel. Plywood panels, that are

completed in November and onwards are not liable to damage until the following rains. Such material can leave the factory with a guarantee of being free from infestation by *Heterobostrychus*. Panels that must be held in stock for longer than six months or throughout the rains can be protected (if damage is expected) by strapping up in units comprising sufficient panels to form a cube, boxed in by panels on all sides; these cubes should be stacked with narrow battens between each in the vertical tiers.

Glues for veneers usually contain an antiseptic such as sodium fluoride. Five per cent. of sodium flouride added to the dry mix is sufficient to check the passage of larvæ from one veneer to the next.

CONCRETE FLUME DAMAGE

By N. G. Pring.

The flume is part of the hydro-electric works situated at Chaba on the Sutlej river which supply Simla with light and power, and which were designed and constructed by the late Colonel Battye of Mandi hydro-electric scheme fame. Mr. Maelzer who accompanied the writer was also on the construction in 1911-12.

The flume conducts water from the Nauti khad, elevation 2,624 feet, as far as the reservoir elevation 2,610 feet, a distance of 2·6 miles. At the terminus which is 550 feet above Chaba, water is harnessed by means of a pressure duct and steel pentstocks, and also feeds the 34,900 gallon storage reservoir. The flume is four feet × four feet, except where it has been widened at intervals to form silt traps, and has a capacity of 40 cusecs. It is constructed of nine inch thick lime concrete faced on the inside with a very thin layer of cement plaster. A narrow foot-path runs along one or both sides except through a man high tunnel, now the haunt of water snakes and countless bats. The hill side is mainly steep and occasionally precipitous with a general easterly aspect. The underlying rock is chiefly lime-stone with belts of shale and some striking conglomerates at the junctions. The vegetation is typical sub-Himalayan scrub reduced by browsing in places to unpalatable or armed species, but, as a rule, much denser than similar

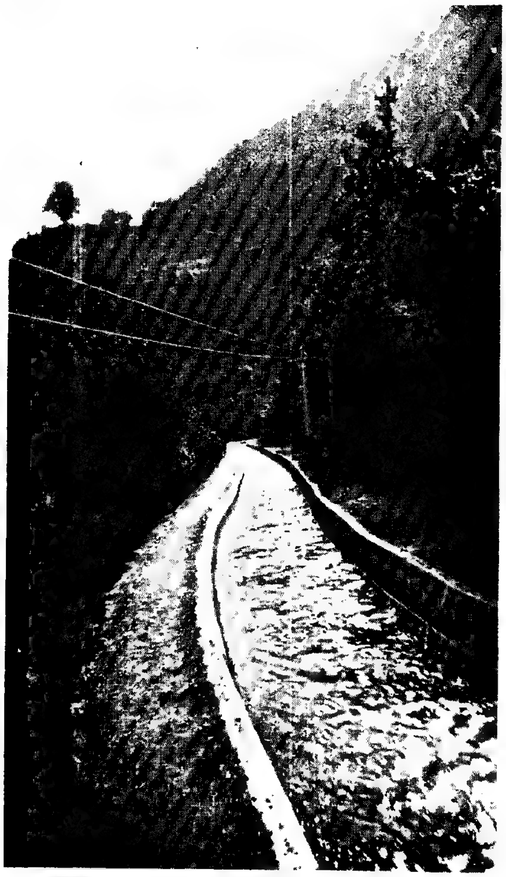
undemarcated forests of the main Sutlej valley. The following trees are very common :—

Acacia catechu, *Bauhinia* spp., *Bombax malabaricum*, *Ficus* spp., *Grewia* spp., *Mallotus philippinensis* and *Pyrus pashia*. Of the shrubs :—

Adhatoda vasica, *Carissa opaca*, *Debregeasia hypoleuca*. *Dodonaea viscosa*, *Woodfordia floribunda* and *Zizyphus* spp. are among the commonest.

Of the figs, *F. palmata* is the commonest along the flume, and *sanatta*, *D. viscosa*, the commonest shrub; the latter sometimes forms a regular hedge, individuals reaching a height of more than 15 feet. A good deal of damage to the masonry has recently been caused by tree roots which work their way through the concrete or cause the sides to bulge inwards. Roots which penetrate the flume between the side and the bottom cause the greatest leakage, but most damage is caused by penetration from the upper hill side. In such cases an accumulation of water percolates under the flume, and, by washing away the earth, leaves a passage for heavy monsoon torrents, which sometimes carry away sections of the flume. Examination showed that figs were obviously bad offenders; in one case penetration was traced to a medlar, *P. pashia*, and in another to a cotton tree, *B. malabaricum*. Of the numerous *sanatta* no case of penetration was discovered, one case of bulging may have been caused by a very large *sanatta* but was more likely attributable to a *kamila* (*M. philippinensis*) growing along side, because elsewhere *sanatta* growing almost horizontally from the lower bank at flume level had done no damage.

A typical case of root penetration was traced to a much branched stunted fig, *F. palmata*, growing above the flume. First the root passed through about five feet of lime-stone rock and then ran nearly seven feet along the outside of the rock, throwing off two minor branches. The exposed portion which averaged slightly under 3 inches in circumference had been injected with asafœtida, but except for slight decay at the point of injection, no effect was noticeable. Entering the soil at the base of the rock the root turned towards the flume, which it



The flume on the left is a *sanatha* hedge.

Ficus palmata root damaging the flume.

The reservoir above Chaba.

met eighteen inches from the top, sending one branch through the concrete and cement facing, which it had burst. The lower of the branch roots thrown off from the exposed portion had entered the concrete, as had two small roots from the net-work below the soil. This net-work connected with a much larger root running below the flume and with a small fig, probably a sucker, nearly 30 feet up-stream. Probably very fine roots entering the concrete were broken during digging operations. Cases of penetration have only been spotted since 1932, and from the number of roots that had entered the concrete it is obvious that damage will increase with time.

Trees responsible for damage have been cut down but in many cases they have coppiced or thrown up root suckers, so that damage has continued. Stump and root injections of coal-tar, nitric acid and asafœtida have given negative results.

The following remedies are now to be tried :—

(1) The cutting out of figs along the flume and their replacement with *sanatta*. Subsequent root suckers and fig-seedlings will have to be stubbed out and sown over as well for some time. Individuals of other species actually damaging the flume will be treated similarly. *Sanatta* grows extremely well along the flume, regenerates naturally, affords excellent firewood and is not browsed. Should larger stems be found to damage the flume they can be cut out and replaced by plants which can be clipped to form a hedge.

(2) The construction of a half inch thick cement plaster on the outside of the flume where fig or other roots are causing much damage and where eradication proves difficult.

The Chief Engineer, Simla Electricity Department, would be grateful for any suggestions for eradicating this trouble cheaply by chemical injections.

[Several articles have previously appeared on the subject in the *Indian Forester* and they might be consulted with advantage. The articles can be traced in the following issues of the *Indian Forester* :—

February 1917, pp. 106-09 ; January 1918, pp. 23-24 ; January 1919, pp. 22-25 ; October 1921, pp. 422-23 ; April 1923, pp. 197-207.

Atlas tree-killer is supposed to be very effective, but it is rather expensive. The active principle of Altas is probably sodium arsenite, which can be purchased cheaply. The method of application varies, ordinarily it is painted on a girdled belt or on the stump. The *Malayan Forester* published a letter in July 1932 at page 220 and method of treating a *Ficus* tree was to bore holes about four inches deep and half inch wide round the base of the tree. The undiluted solution was then poured into the holes. Subsequently solution with half water was used and in about six months the tree was dead. Failures with these preparations are usually due to insufficient attention to correct conditions for application. Nitre is also said to be used by builders but exact details are not forthcoming.—*Ed.*]

MEMORANDUM ON CHANGA MANGA SISSOO.

BY ALLAH BAKHSH, I. F. S.

During 1927 some *shisham* timber was supplied to the Mayo School of Arts, Lahore, from Changa Manga Plantations. This Institution specialises in high class furniture. It was complained that the timber supplied was very defective and unsuitable for high class furniture. In Hoshiarpur no Changa Manga *shisham* is used for ivory in-laying and most of their requirements are met from roadside trees. On the other hand, all Kartarpur manufacturers buy their requirements for furniture from Changa Manga and meet all their requirements from III class *shisham* logs and thick fuel mainly representing crooked logs of five feet length.

The Mayo School of Arts complained that all pieces that were sawn out of these logs showed (1) yellowish green tinge, (2) wild dark figures, (3) lime-like deposit, and (4) cross grain. The letter received from the Principal of Mayo School of Arts is extracted below :—

"This wood has now all been sawn and stacked and slated in our timber shed and I am compelled to state that it is the worst quality *shisham* I have ever seen. It is all of the type known in the bazaar as " male *shisham*," *i.e.*, very hard, coarse and irregular in grain, cross grained and a greenish yellow tint with a very wild

dark figure, utterly unfit for making good furniture. It is moreover full of lime-like deposit, with many knots, most of which are "dead," *i.e.*, they loosen and fall out in time. It can only be used in small sections. It is impossible to make a table top of it. The wild nature of the grain renders it impossible to secure a good finish and for the same cause the planks twist, warp and split whilst being seasoned. I have subsequently learned that the Changa Manga *shisham* is all affected with some disease or fungus. Certainly there are many greenish patches in the planks which spoil them for good work."

The writer then examined 40 planks sawn in Changa Manga for building purposes and found that every one of the planks contained one or more of the above imaginary and real defects.

Samples of planks containing these defects were forwarded to the Forest Economist in December 1927 and he reported as follows :—

"*Yellowish green tinge.*—This can be removed by exposing it to strong daylight and the wood tones to an even brown colour when so exposed.

Wild dark figures.—This constitutes no drawback in the timber except for furniture where even dark brown coloured wood is required. On the other hand, wild dark figures are considered to be an asset and most people would pay a high rate for this timber, as they are far more handsome when made into furniture.

Lime-like deposit.—This is probably potassium nitrate, a residue after the sap had evaporated and can be removed by crude vinegar, one part of acid to eight parts of water used hot.

Cross grain.—This is the only defect of any importance which is difficult to overcome although it often can be got over by proper sawing and it was actually found that tangential sawing and machining gave the best results."

Paras. 3, 4 and 5 of the Forest Economist's letter, dated 26th April 1928, are quoted in full :—

"3. It was found that tangential sawing and machining gave the best results, but the timber is so badly interlocked that the

fibre picks out under any conditions of working, making it costly to bring the wood to a fair finish by means of hand planes, scrapers and glass paper.

4. Due to variable densities, uneven and badly interlocked fibre, the planks warped, twisted and split inside 20 hours after conversion. We are afraid that this is a matter out of our control and the peculiar construction of the timber rules it out for planking. It may, however, be suitable, in scantling form, for rough cart building and work of that description, but there is little hope of it being used for good class cabinet and furniture-making as even if the planks remained straight the cost of hand finishing would be excessive.

5. In conclusion, I cannot help feeling that the specimen sent to us was somewhat exceptional. We have handled large quantities of *sissoo* here and we have never seen a specimen like the one sent. In Bareilly, the centre of the United Provinces furniture industry, *sissoo* is the standard timber used and we have never heard of any such complaint as your before in connection with this wood."

It is correct that the worst specimens of cross grain were purposely sent by selecting planks of the worst type.

It was then decided to examine six pieces selected at random and the defects previously noted were found repeated in this. The report of the Forest Economist on these specimens is quoted from his letter dated the 25th July 1928 :—

"I have to inform you that exhaustive working tests have been carried out on all of the six scantlings of *sissoo* (*Dalbergia sissoo*) sent by the Range Officer, Changa Manga, and the results obtained were identical with those of working tests carried out on the specimens reported upon in my letter No. 7/46-3/S., dated the 26th April 1928. This *sissoo* is very cross-grained and has much interlocked fibre. It would be a waste of time trying to work it up to a good finish. The timber would of course be perfectly good for work where toughness and strength are required, such as for cart-building, but if *sissoo* timber is required for furniture, this wood is

practically worthless for the purpose. I can assign no reason for the extensive interlocking of the fibres. It is one of nature's freaks. I have never seen *sissoo* so cross-grained before. It took us three hours to work one square foot up to a reasonably good surface and even with hand planing the fibre tore up on all sections."

In November 1928, three scantlings from river-side plantation timber were forwarded to the Forest Economist for examination by the Depot West Division. It was reported on by the Wood Workshop Section as follows :—

* * * * * * *

"Unlike the material reported upon under this office letter No. 402/W. W./28 of 19th April 1928, the *sissoo* under test was more characteristic of Dehra Dun *sissoo*. It was free from worm attack, was not so wild, and did not warp, twist, or split, and works to a fair finish at a cost comparable with the working costs of teak.

If properly seasoned and hand finished, there appears to be little or no reason against this *sissoo* being used for furniture, except perhaps that the yellow tinge, as described by the Principal, Mayo School of Arts, may be objected to.

It is our experience that a white lime-like deposit is present in most *sissoo*, but this is not a deterrent to the use of *sissoo* as a furniture timber, as the stains disappear with polishing and age."

This was considered superior to the Changa Manga timber and a normal sample of the species, although it contained a white lime deposit and yellow colour. The Forest Economist visited Changa Manga in 1934 and found that the timber varied considerably not only in colour but also in straightness of the grain. His remarks are noted below :—

" The colour varied from dark brown figured wood to pale straw-coloured timber, and while some logs appeared to be of straight-grained clean timber others contained wood of a very cross-fibred nature."

He arranged to get three more logs (1) Dark *sissoo*, (2) Light coloured straight grained *sissoo*, and (3) Light coloured cross-grained *sissoo*. The results of examination of these three specimens are given in the statement below.

The Wood Technologist's report is quoted below :—

"I have examined the three varieties of *sissoo* from Changa Manga. All three have got interlocked grain. In the so-called "light-coloured cross-grained" sample interlocking has been found in thin bands of fibres while in the other two varieties interlocking is in thick bands. This partly explains the difficulty experienced in machining and planing this wood. Moreover, on microscopic examination I find that "the cross-grained" sample shows small patches of crystal deposit throughout the wood. These crystal deposits are confined to the parenchyma cells, pores and rays. The size and the shape of these patches are irregular and their occurrence is erratic."

No. 1. *Dark sissoo.*—

The Wood Workshop Section reported on the dark coloured specimen that it was a little hard in working but was quite suitable for furniture-making, panelling and flooring. It will stain and polish well. It was little hard in sand-papering and scraping but it finished fairly well.

No. 2 *Light straight-grained sissoo.*

This was found easy to work both by machine and hand and it behaved normally and was considered quite suitable for high class furniture. It stained and polished quite well and was very easy to scrap and sand-paper.

No. 3 *Light cross-grained sissoo.*

It was hard to work both by machine and hand and dulled the teeth of a saw. It was found harder than No. 1 in scraping and sand-papering, but it can be finished fairly well.

The working qualities of dark coloured *sissoo* appeared to be midway between those of cross-grained and light-grained *sissoo.*

The Timber-Testing Section reported that the tests did not reveal any significant strength difference between the three samples, and there was comparatively no choice between different samples purely on strength basis.

In Changa Manga the local carpenters who are carrying on the timber trade and manufacture bed, bed-legs, recognise two types of *shisham* timber (1) straight-grained and easy to work and (2) cross-grained. The former is termed as "female *shisham*" and the latter "male *shisham*." The examination so far carried out definitely shows that Changa Manga produces good straight-grained timber as well as very badly cross-grained *shisham*.

The investigations carried out so far open out a very desirable field of further enquiry on the subject. It is difficult to say definitely that there are two distinct varieties of *shisham* grown in Changa Manga but further investigations are likely to prove that these differences are due mainly to inherited characteristics. It is possible that "male" and "female" trees as the term is used by the carpenters may be distinguished by definite characteristics as standing trees in the forest.

Whether the cross-grained *sissoo* is the result of plantation conditions can be easily determined by testing Chichawatni, Khanewal and Daphar *shisham*. If any of the plantation *sissoo* proves an exception it can be definitely concluded that cross-grain is not the result of plantation conditions and is probably due to inherited characteristics. It would be interesting to test a fairly large number of specimens from roadside trees in the vicinity of Changa Manga outside the plantation, as even if a few trees show an excessive cross-grain it will definitely prove that it is a local characteristic and not the result of plantation conditions.

During the recent Silvicultural Conference held at Dehra Dun, it was pointed out that there were definite growth forms of *shisham* and it is quite possible that such an investigation will lead to useful results.

It is difficult to say to what extent results obtained from such an investigation would be of use in practical application, as *shisham* seeds profusely and seed is carried about by wind and water. If definite growth forms can be distinguished from early age as was done by Mr. Trevor at Daphar there seem to be possibilities of excluding any undesirable forms from the plantations, firstly by keeping out extraneous seed by means of wire gauze filters fixed on water channels, and later by weeding out any undesirable forms.

REVIEWS.

A REFERENCE WORK ON INDIAN DRAGONFLIES.

Fauna of British India, Odonata, Vol. II, by Lt.-Col. F. C. Fraser, I.M.S., pp. i—xiii, 1—398, 120 *figs.*, 4 *plates, London, October,* 1934.

In the *Indian Forester* for September 1933, p. 597, we reviewed the first volume of Lt.-Col. Fraser's monograph of the Indian dragon-

flies which furnished an introduction to the study of this group of insects and dealt with 39 genera and 168 species of the first family of the sub-order Zygoptera.

The second volume appears with a celerity that is unusual in the study of insects in the Indian fauna and much of its promptness is due to the fact that it is based on the series of papers on Indian dragonflies published by the author in the *Journal of the Bombay Natural History Society*. Several species not included in that series have been added and most of the text-figures have been redrawn and four charming coloured plates have been provided. 171 species or sub-species are described in 44 genera bringing the recorded total up to 340 species and leaving about 160 species in the order to be dealt with in a future volume.

This work is recommended to those who wish to collect in a well-defined group of insects, available everywhere, and worthy to rank with the butterflies for showiness and general interest. There is an excellent glossary which makes the use of the keys and descriptions quite simple to the beginner.

C. F. C. B.

BUCH DER HOLZNAMEN.

PART I. A—CA. PART II. CE—ISE.

BY DR. HANS MEYER.

(*Hannover : M. & H. Schaper-verlag*, 1933).

The book of wood names, or more appropriately the dictionary of wood names, is an admirable compilation by Dr. Hans Meyer, Curator of the Institute for Applied Botany, Hamburg University, Hamburg, Germany. Various trade, common and vernacular names of woods, which are in vogue either in the country of origin or in countries where those woods find a use, are listed in alphabetical order, each name being followed by the botanical name of the species from which the wood is derived, natural family and the country of origin. In case, where a name is employed only in a particular country, other than the country of origin, an abbreviation within brackets after the wood name indicates the locality of such usage.

With the increasing use of imported colonial woods in European countries, there is no doubt that the need was being felt for a reference book of this kind not only by the wood technologist, who is at times required to identify unknown timbers of obscure origin, but also by the timber trade, wood users and by certain government departments. The only other useful index of common trade and vernacular names of woods is that given at the end of the "Timbers of the World" by Alexander Howard, a new edition of which has recently come out, and although it is a fairly comprehensive one, it is by no means as complete as the book under review.

The attempt made by Dr. Meyer is, no doubt, a praiseworthy one, but the work would have gained added authority and would certainly have been of greater utility, if Dr. Meyer had taken into collaboration forest officers from different countries of the world, competent to advice him on the local names of the woods most generally employed in literature. Speaking for India, the vernacular names of each species are so numerous that the inclusion of all of them in a list of this kind would have simply made the task an impossible one. Referring to Gamble's "Indian Timbers," one finds that some of the species have more than 50 names. For instance, *Holarrhena antidysenterica* Wall has a list of 51 vernacular names, which may possibly be still incomplete. The index to vernacular names at the end of Troup's "Indian Woods and their Uses," covers a total of 202 large sized pages. A reference to all these, apart from making the book too bulky for ordinary use, would have defeated the primary object with which the work was undertaken.

Looking cursorily through the pages, one finds that there are quite a few entries which require correction. For instance, on page 171, *eng* is given as being applicable to *Dipterocarpus turbinatus*, Gærtn. f. and to *Dipterocarpus pilosus*, Roxb. Again on page 229, *in* is referred to as *Dipterocarpus* spp. Both the names *in* and *eng* have been definitely reserved in common usage for *Dipterocarpus tuberculatus*, Roxb. On page 79, *white bombwe*, is referred to as a

common name for *Careya arborea*, Roxb., while it is exclusively applicable to *Terminalia procera*, Roxb., which should be given instead. On page 9, *agar-agar* is given as a common name for *Aquilaria agallocha*, Roxb., which should be *agar*, or *agur*, but not *agar-agar*, which confuses it with the well known material of that name used for preparing bacteriological media. On page 7, *adiana* is given as a common name for *Adina cordifolia*, Hook. f., but I have been unable to trace it in any of the well-known reference books. Some very obscure names are mentioned, such as *achara* for *Picea morinda*, Link, which is only used in Chitral, and is seldom met with in literature. On the other hand, names like *benteak* for *Lagerstrœmia lanceolata*, Wall., and *ekki*, which is a standard trade name for *Lophira alata*, var. *procera*, Burtt Davy, are missing. It is hoped that in the next edition, it will be possible to remove such shortcomings.

Standardization of common names of woods by international agreement is a hope expressed by the author, for which his book may serve as a basis. It appears to me that the time is yet far from ripe for this kind of thing. A number of less developed wood producing countries have as yet no agreed lists of common and trade names for their important commercial species, and those countries which do have such lists, they have to be further elaborated before they can be said to be complete. The Empire Forestry Conference at their last meeting in Australia in 1928 undertook the task of compiling a list of trade names of Empire Timbers, and they decided to fix names only for a limited number of botanically well identified species, which find or are likely to find a regular market in Great Britain in adequate quantities. Considerable work has yet to be done by individual countries interested in the matter, and, in due course, it may be possible that either the International Union of Forest Research Organisations or the International Association of Material Testing would take up the standardization of wood names, and Dr. Meyer's book will no doubt be useful then as a starting point for any such discussion.

21st December 1934. S. N. KAPUR.

IDENTIFICATION OF THE COMMERCIAL TIMBERS OF THE UNITED STATES.

By H. P. Brown and A. J. Paushin.

(*Published by McGraw-Hill Book Company, Inc. Price* 18 *shillings.*)

This is the first book of the American Forestry Series which "is intended for the College student, the practising forester and the men in the forest industries." It contains some elementary information on the gross anatomical features of wood, its non-mechanical physical properties and its minute anatomy. In a few pages the authors have provided the necessary background required for the understanding of two keys—one macroscopic and the other microscopic—which come next. The keys are dichotomous and seem to be easy to follow. Lastly the descriptions of the species included in the book have been given; a full description of general characteristics of each species is followed by a short note on its minute anatomy.

In the chapter on minute anatomy some excellent photomicrographs depicting cell elements of non-porous, ring-porous and diffuse-porous wood have been given. Here, authors' treatment of pits and longitudinal parenchyma cells is rather brief. As the book is primarily meant for the forestry students, it would have been better if they, at this stage, had a proper understanding of these two subjects on which so much depend for the correct identification of wood by minute anatomy. At the end of this chapter, the authors have inserted a note asking the readers to refer to other text books on wood anatomy for the further information on the subject but this work itself contains very few references of other books or papers. Interested readers will not, therefore, know what book or paper to refer to for further information.

The low power (5X) photomicrographs of the cross section of wood have been included. These are negative prints and have been reproduced very well. The high power (75X) photomicrographs of the cross and tangential sections of wood have also been given. The best part of the book seems to be the excellent photomicrographs that it contains. The printing and the get-up of the book is excellent. On the whole, it is a welcome publication on the subject of wood technology.

K. A. Chowdhury.

EXTRACTS.

THE TYPICAL BUSINESSMAN.

(BY JOHN A. CRABTREE IN THE "*Crabtree.*")

I have often wondered if there is any such person, and if so, what he is like. We sometime find him described in novels as the strong, silent man, highly efficient, big in physique, with a fist like a mallet and a face like granite. He is usually presumed to possess a powerful mind which runs steadily like a great river and with the sustained and terrific energy of a river in flood, he is entirely relentless and ruthless. At other times he is described as towering above men like a Colossus, the while we lesser folk run about his legs and peer wonderingly up into the clouds where his mind dwells. Withal, you never see him work, as normal men have to work. Place a complicated problem and a pile of documents before him, and he will flick them over and give his decision in a moment. His desk is bare. He has no routine. His "yes" is a rare nod; his one word "no."

To the cartoonist he is many things. Will Dyson show him as a million people think he is; equatorial expansiveness, exaggerated by a white waistcoat, while spats and a silk hat decorate his extremities, gold watch chain and expensive jewellery display his sterling qualities, and his cranial capacity is barely adequate to give a motive impulse to his clutching fingers. He's not unlikable, for when he is not vicious he's near to being a complete ass, and any ass is usually likable when he so obviously demonstrates our own mental superiority.

I think, however, that Strube gets nearer to the truth with his "little man," that poor soul, for ever perplexed, yet for ever hopeful. If the earth rocked, he would climb upon the ruins, if the heavens fell, he would still search for the sunlight. He is like the man of whom someone once said: "If he met a great obstacle, he would climb over it; if he couldn't climb, he'd get round it, if he couldn't get round it—well, he'd sit in the shade and make the best of it."

And yet I have still to meet in real life the typical businessman of either the novelist or the cartoonist. True, there are types. You find, for example, the engineer type, the commercial type, the financial type and the professional type.

The engineer type covers that class which is creative in a physical sense. He is the craftsman, turned businessman. His urge is to use his hands. He wants to make things in a material sense, and his eternal problem is to recognise that he cannot do everything himself, and therefore he must learn to be content with others doing work less efficiently than he thinks he himself can do it. As he grows older, a very considerable influence continues to be exercised upon his development by the outlook he acquired at school or in his early training, and his method of approaching his problems, will, to a large extent, depend upon the technique drilled into him as a youth.

This type is the usual one in the electrical industry, which is yet a new industry compared, say, with cotton or iron and steel. You meet him daily as supply

engineer, contractor, factor, and manufacturer, but he is passing away, and the commercial and professional businessman is taking his place in the electrical industry, just as he has done in other industries.

The commercial type seem to be concerned with values, rather than with things. He has the advantage over the engineer type in that he tends to see the whole rather than the detail; and to have the reliability of an administrator, rather than the eccentricities of an originator. Where the engineer type might try an experiment to see what will happen, the commercial type tends to be more cautious. He rather wants to copy other people's experiments.

The engineer thinks in terms of C. G. S. units, and makes things; the commercial mind thinks in terms of exchange values, and makes money.

The world however needs both types, for in their highest expression the one is the scientist in production, the other is the scientist in distribution.

Most of us fit into one or other of these two main types. Some of us, like the supply engineer, have grown up as one type, and are now having to adjust ourselves to the other type. The process is not an easy nor is it a happy one, for the work which first attracted our creative enthusiasm is pushed into the background, and we have increasingly to give attention to values, technique, and responsibilities, which are often alien to our early training and outlook.

There are, however, other specific types of businessmen, which may be said to come only in part within the two types already mentioned.

The financial type is one such, who seems to be almost a type on his own. By this type I do not infer either the banker or professional man of the ordinary accountancy type, but rather that type of mind which has a highly developed sense of values in terms of hard cash, without any of that emotional impulse which leads a man to pay more for a thing than it is worth because he wants the money. Such men are masters of measurement in terms of £. s. d., and, just as the mind of the engineer refuses to recognise a two-inch shaft as being anything but a two-inch shaft, so the financial mind refuses to recognise any other measurement than that assessed by his own keen financial judgment.

A further and new type is now coming along in business, which as yet has only recently entered the electrical industry, the professional businessman.

I would define the original difference between the professional man and the ordinary businessman as being in the function of responsibility. In a broad sense the professional man has no responsibility for decision. He only advises, and whether his advice proves right or wrong, the businessman is left to make the decision and to pay the price, he still has to pay, even his mistakes are due to faulty professional advice. Such a distinction may be challenged in specific detail, but in the broad sense I believe it to be true. It is somewhat akin to the distinction in responsibility which exists between the head of a Civil Service Department and the Cabinet Minister.

Eventually however this distinction will be lost, and the professional man will assume the responsibilities and prerogatives of the old style of businessman. You find this happening already in the larger and older business undertakings, where the Board of Directors—the Managing Directors—are being chosen, not because they understand the specific industry or the specific business, but because they understand business as a whole in a professional sense. There are many instances of this to-day, some even in our own industry, and it may be that business as a whole is in process of evolving a new Civil Service of its own, not unlike the Civil Service of the State, but with all the prerogatives of policy, control, and with all the advantages of proprietorship without any of the attendant risks which ownership must involve.

The world is barely conscious of the extent to which ownership as such (shareholding, etc.) is ceasing to function over a large section of our industrial and commercial life, and the authority of ownership has by default become the prerogative of a new professional type of Civil Service in Big Business.

As we are all in some measure a combination of these types, with one or another predominant in us, it would seem to be ideal that we should be a combination of *all*. This I am inclined to doubt, for it is better for mankind that each one of us should be specialists in our individual fields, than that we should all be moulded into a uniform and standard pattern. Most of the interest, indeed, would go out of life—and certainly out of business—if it were not for the great variation in our outlook, our separate personalities and our individual ways of doing things.

The electrical industry is one of the few remaining industries in which men still count as men, but it is inevitable in the process of life that the function of important sections of the industry will be challenged in the next generation. It is quite within the range of possibilities that the type of " Engineer Businessman " who created this industry will be almost entirely wiped out by what —for want of a better word—I would call not the Businessman —but the Business Administrator. I wonder what sort of a job he will make of things ?

(*The Indian and Eastern Engineer*, March 1934.)

(The Indian and Eastern Engineer, March 1901.)

DROUGHT ON A WET PLANET.

By Charles Fitzhugh Talman.

The disastrous effects of lessened rainfall, and the widespread havoc that often follows extended periods of dry weather.

According to a recent estimate, the amount of water lying at all times on the surface of the earth exceeds 332,500,000 cubic miles in volume and weighs more than 1,500,000,000,000,000,000 tons. Every second of the day and night something like 16,000,000 tons of this vast store passes into the atmosphere by way of evaporation and is spread abroad by the winds. At the same average rate of 16,000,000 tons a second, water falls from the sky as rain and snow upon the lands and seas of the globe. We live, therefore, upon a wet planet.

Why, then, such disasters as the one that has taken toll this year in the United States to the extent of thousands of millions of dollars? Why should humanity ever suffer widely for lack of water in a world so generously supplied with it?

There are two explanations of the paradox. First, Nature is outrageously capricious in her distribution of rainfall. About one-third of *terra firma* is always barren because of persistently deficient rain. Another third gets too little on an average to make agriculture a profitable occupation. Over almost all the rest, the farmer's business is a gamble on account of frequent or occasional droughts.

Second, man still depends for nearly all his food and clothing directly or indirectly upon plants, which are exceedingly wasteful in their use of water. Plants collect and utilize only a fraction of the rain that falls on fields, pastures, and forests, and they require relatively enormous amounts of water to produce small amounts of material useful to mankind. Probably some day all of food stuffs and clothing materials will be manufactured directly from elementary substances within the walls of factories instead of being produced by the slow, wasteful, and precarious methods of agriculture and grazing, and then the scourge of drought will be a thing of the past.

The word "drought" applies literally to any state of dryness; but when we speak of "a drought" we usually mean a protracted period of dry weather more or less abnormal for the region where it occurs. Our conception of a drought implies, moreover, certain conspicuous effects of such weather, either as exercised directly or through the depletion of water in the soil. These include the withering or stunted growth of vegetation, the shrinking of streams, and the failure of wells and springs.

Mere scarcity of rain does not necessarily bring about droughty conditions. Loss of water from plants and from the soil through evaporation usually plays an important part in drought, and this process is favored by hot weather, low atmospheric humidity, and high winds. An ideal criterion for defining a "drought" would take account of all factors concerned in reducing available moisture to a harmful extent, but deficient rainfall is the principal factor, and in most quantitative definitions of the term it is the only one considered.

No single definition of this sort has been adopted by meteorologists for use all over the world, because the rainfall requirements of any one region differ widely from those of another, but several have been proposed for use in particular countries. Two have been employed in certain publications of the United States Weather Bureau. According to one, a drought is a period of 30 days or more during which the rainfall does not amount to 0·25 inch in any 24 hours. The other defines a drought as a period of 21 days or more during which the rainfall is not more than 30 per cent. of the normal.

What is a Drought?

In Great Britain the Meteorological Office describes as an "absolute drought" a period of more than 14 consecutive days without 0·01 inch of rain on any one day, and as a "partial drought" one of more than 28 consecutive days, the mean rainfall of which does not exceed 0·01 inch a day. During the 62 years ending with 1919 there were 69 absolute droughts in London. The term "engineers' drought" is applied

by the British to a period of three or more consecutive months, the aggregate rainfall of which does not exceed half the normal amount for the same period.

The meteorologist is often asked by the layman whether a certain drought was more "severe" than another; or, for example, whether the drought of 1930 or that of the present year or some other should be regarded as the most "severe" in American history. How can we measure the severity of a drought in order to make such comparisons?

The extent of territory affected, the total deficiency of rainfall over the area, and the duration of the drought are obviously factors to be considered in estimating its severity. The disastrous effects of a drought depend more upon the time it lasts than upon the total shortage of rain; hence, according to some authorities, severity increases as the square of the duration. These effects are, however, still more dependent upon the kinds of crops and other vegetation exposed to the drought, the stage of plant growth at which it occurs, and other non-meteorological circumstances.

Thus the task of measuring the severity of a drought is one for the economist rather than the meteorologist. We can say categorically whether a certain drought was more *costly* than another, but whether or not it was more severe in a physical sense is often a difficult question to answer.

So far as the meteorological features of a drought are concerned, the most important one—the shortage of rainfall is best expressed in tons rather than in the customary inches of depth, since not everybody realizes that an inch of rainfall is equivalent to 113 short tons (101 long tons) of water to the acre. This illuminating method of indicating the magnitude of a drought was employed by the Weather Bureau in a review of the great drought of 1930, in which the Eastern States suffered much more severely than they have suffered this year. The statement reads:—

Twenty seven states had deficient precipitation each month for periods ranging from two to twelve months, and the total shortage for these states during the droughty period was more than 700,000,000,000 tons of water. For the eight states—Maryland, Virginia, West Virginia, Kentucky, Ohio, Missouri, Indiana, and Illinois—most effected by the drought, the shortage was nearly 300,000,000,000 tons, and in general, for each 100-acre farm, for the three summer months alone, it was about 60,000 tons, or an average of nearly 700 tons a day.

These figures are given in short tons—2,000 pounds to the ton. Thus the daily shortage during the summer on a good-sized farm in the states mentioned averaged 1,400,000 pounds, or about 167,500 U. S. gallons of water, as compared with the supply in a normal year.

What Plants Require?

Such figures become even more understandable in relation to drought when we consider the amounts of water that growing plants, if they are to live and thrive, must obtain from the soil. For example: A corn plant takes up about 368 pounds of water for every pound of dry matter it produces. An acre of cabbage plants needs more than 2,000,000 quarts of water in a season. Two hundred beech trees on an acre

require nearly double that amount. More than 800 pounds of water must be put into the soil to produce a pound of dry alfalfa. Half a ton of water is used by a tree in making a pound of wood.

Fortunately for the farmer, the supply of soil water in any region is far more stable than the rainfall of the same region, because there is usually a large reserve of such water deep in the ground, which accumulates in rainy weather (as well as from the melting of snow) and is but slowly depleted when the rainfall fails. If plants depended directly upon rain for their supply of moisture, agriculture would hardly be possible even in nominally humid climates, which are, as a rule, subject to occasional dry spells of long duration. Southern New England, for example, is a well watered region with a normal rainfall about double the minimum amount required for ordinary crops; yet statistics show that once every two years, on an average, this region experiences a dry spell lasting 30 days or more, during which no day brings as much as a quarter of an inch of rain.

Lowered Water Tables.

A serious depletion of soil water results from persistent drought, and especially from a succession of droughty years. Gradually the water-table—the upper limit of saturated soil—from which the roots of plants draw water either directly or through the wicklike action of intervening soil, sinks below the reach of all but the deepest-rooted plants. The soil down to a considerable depth becomes so dry and powdery that the water from occasional showers seeps rapidly through it and is lost to plants. With the general killing of vegetation, the bare surface soil is easily swept up by the winds in clouds of dust, which may assume spectacular proportions and spread far beyond their place of origin, as has happened from time to time this year in the United States.

The unprecedented epidemic of dust storms in this country during the past spring and summer, though probably due in part to unwise agricultural methods and extensive overgrazing—both of which have stripped the land of protective natural vegetation—appears to have been also the result of an enormous reduction of soil water in regions where there has been a general downward "trend" of rainfall for many years.

A Decline in Rainfall.

An analysis of rainfall record made by J. B. Kincer, of the Weather Bureau, shows that over a large area of the northern Middle West, centering in Minnesota, this decline has been in progress for the past 25 years, being one of a series of slow upward and downward swings revealed by records extending over the past century. During these swings the rainfall of individual years has sometimes departed widely from the prevailing upward or downward tendency, but the latter is plainly shown by a curve plotted from the averages of overlapping periods of ten years each, each ten-year period beginning a year later than the preceding one.

Similar slow oscillations of rainfall appear to be fairly common throughout the world and there has been much discussion as to their causes. One of their effects has been to foster the delusion that the rainfall of various parts of the world has changed

permanently for better or worse within historic times. Unfortunately these trends, though they are of great economic importance, are too indefinite and irregular to afford a safe basis for long-range forecasts of drought.

With the doubtful exception of floods, droughts have, in the aggregate, cost more human lives and caused more misery and destruction than any other disasters of atmospheric origin. In their ultimate effects—as, for example, in provoking wars, migrations, and social upheavals—they have undoubtedly played a much greater part in human affairs than have all other weather disasters combined. In the United States severe droughts have been the commonest cause of commercial panics and have often caused an extensive transfer of population from one part of the country to another. Before immigration was restricted, every great drought in Europe promoted a larger exodus than usual to the New World.

The days of famines due to drought are by no means over. Russia and Persia have experienced them on an immense scale during the present generation; China, which suffers from them at frequent intervals, is enduring a terrible one now. In the past they were not only commonplace events but were viewed complacently by philosophers and government administrators as a natural check on the growth of population.

Droughts and Famine.

Until England shouldered the white man's burden in India, the droughts of that country caused famine on a colossal scale. One reads in the old chronicles of drought-bred famines in which " the land became densely covered with bones in all directions, until it was like one great burying-ground." The famine of 1769-70 destroyed one-third the population of Bengal. As recently as 1876-77 five million people died of hunger in India as a sequel of drought.

In civilized and well-governed countries to-day human beings no longer perish of hunger and thirst in time of drought, though they still endure much misery on account of the visitation and a good many may eventually die from its indirect effects. One common result of prolonged drought is the pollution of drinking water, leading to outbreaks of typhoid and other diseases. On the other hand, a severe drought, wherever it occurs, causes suffering and mortality on a vast scale among the lower animals, both wild and domesticated. Many thousands of animals purchased this year by the United States Government to save them from starvation were so emaciated that they were unfit for shipping to market. In the summer of 1930 it was reported that more than 10,000 horses died in the fields of Iowa in a single week.

In her vivid novel, *The Wind*, Dorothy Scarborough pictures this phase of a drought as witnessed on one of the old-time Texas ranges, where the water holes had dried up and there was no railroad near to haul water :—

The plains in their terrible distinctness showed dead prairie dogs, dead jack-rabbits here and there. They had perished for lack of food and water. Only the coyotes remained, and they prowled night and day, for they lived on flesh and grew fat on the bodies of the dead. There were no song-birds left; only the buzzards—carrion birds.

Gaunt, cadaverous beasts staggered about, tortured by heelflies that nagged them constantly; bawling in distress, searching everywhere for food and water. They had devoured every spear of the dried bunch grass and needle grass, every leaf and bean from the mesquite bushes, every stalk of last year's weeds, and now there was nothing? They came close to the house, as if making appeal to their masters not to abandon them to death.

They pawed the ground, as if to find food deep-buried there; some greenness under the tricky sand, some water beneath the burning desert. Some of them threw their heads around to the side, as if the torture of thirst twisted the muscles. Their tongues swelled, turned black, protruded from their mouths. Some of them went mad from thirst and fought, goring each other to death.

Captain W. F. Owen, in the narrative of his African voyages, tells how the large town of Benguella, in Portuguese West Africa, was once invaded by thirsty elephants, who fought a bloody battle with the inhabitants for possession of the wells. Darwin, in his Naturalist's Voyage, pictures the frightful ravages wrought by the "gran seco" of 1827-30 among the cattle of Argentina, a million head of which perished in the province of Buenos Aires alone. He says:—

"I was informed by an eye-witness that the cattle in herds of thousands rushed into the Parana and, being exhausted by hunger, were unable to crawl up the muddy banks and thus were drowned. The arm of the river which runs by San Pedro was so full of putrid carcases that the master of a vessel told me the smell rendered it quite impassable. Without doubt several hundred thousand animals thus perished in the river."

The effects of a great drought are extremely varied. One, of which we have heard much this year, is a marked increase in the number and destructiveness of forest fires.

Apart from this effect of drought on forests, millions of saplings die for want of water, and the larger trees that survive make much less than the normal annual addition of wood to the nation's timber resources. With the exhaustion of pastures, poisonous weeds are extensively eaten by live-stock, resulting in much sickness and mortality. Some insect pests thrive on drought, though others, fortunately, are curbed by it. Scarcity of water for industrial use sometimes occasions heavy losses; as, for example, where large hydro-electric plants are forced to close down or resort to steam. The whole catalogue of evils that drought brings in its train is much too long to set forth here.

What Causes Droughts?

The causes of droughts are disturbances—of unknown origin– in the normal circulation of the earth's atmosphere. It is the winds that spread water vapor over the earth and, as they cool, especially by expanding as a result of upward movements, condense it into clouds and deposit it as rain and snow. An active interchange of air currents tends, in general, to bring precipitation; a stagnant state of the air to bring dry weather

The trade winds of the South Atlantic Ocean supply rainfall—too much of it, at times—to north-eastern Brazil, but it appears that now and then these winds slacken or shift a little from their habitual courses and then the "Nordeste" suffers from the ruinous droughts for which it is world-renowned. The south-west monsoon blowing in summer and autumn from adjacent waters provides the bulk of India's rainfall; but in some seasons the monsoon is weak or irregular, and the crops fail. The swirling winds of "lows," or barometric depressions, that travel in endless succession from west to east across the United States bring us ample rain or withhold it, according to their frequency and intensity and the courses they pursue.

Distant Causes.

The atmosphere is always quite unevenly distributed over the globe—piled up in some regions and deficient in others—as can be seen from a comparison of barometer readings made simultaneously at different places, and variations in these inequalities of atmospheric mass and pressure, displacements of air and attendant dislocations of wind systems appear to be more or less definitely interconnected all over the world. Thus abnormalities in the Indian monsoon are found to be related to abnormalities of winds and weather in South America, the Aluetian Islands, and other distant regions; and it is not improbable that a drought in Iowa or Nebraska may be related to unusual atmospheric conditions that prevail in places thousands of miles away.

One of the most striking recent developments in meteorology is the eager search now in progress for "teleconnections" of world weather and the attempts made—officially in India and some other countries—to predict the dryness or wetness of coming seasons on the basis of these inter-relations.

(*Natural History*, October 1934.)

INDIAN FORESTER

MAY, 1935.

A SCHEME FOR DETERMINING THE IDEAL SEQUENCE OF FELLING IN PASTURE FORESTS.

By K. P. Sagreiya, I.F.S., C.P.

Soon after the management of the open deciduous forests of the Central Provinces was taken up by the Government, some sixty years ago, it was realised that unlimited and continuous grazing, which was the general practice so far, was resulting in a gradual deterioration of the tree growth and the pasture. Therefore, to arrest this process of devastation, regulation of grazing became one of the primary concerns of those who were entrusted with the task of conserving and improving the forests. The first constructive step in this direction was the permanent closure of large stretches of the forest to grazing of domestic cattle. But as the extent of the private grazing grounds and their yield gradually diminished, owing to more and more of the area being brought under the plough, and also due to the deterioration of pasture as a result of reckless fellings and excessive grazing, the demand for grazing in the Government forest intensified to such an extent that the policy of complete closure of extensive area of the forest had to be modified, after it had been in force for well nigh two decades. This change was also considered necessary on silvicultural grounds, as it was found that continuous closure had resulted in a rank growth of grass in some of the sheltered valleys, which seriously interfered with the free development of forest seedlings. It was now laid down that hereafter forests were to be closed to grazing only while they were being regenerated, *viz.*, immediately after the main felling, to give the seedlings and the young coppice time to grow to a size so that cattle could not do them much damage. A period of 10 to 15 years was considered adequate for this purpose. As the forests were mostly worked under felling cycles of 30 to 45 years, the scheme amounted to a rotational closure of 10 to 15 years after every 20 to 30 years of continuous grazing. A description of the forests treated in this manner down to the year 1915, shows that they had distinctly improved in quality. But the scheme was far from being ideal ; and in fact it brought certain evils in its train which ultimately led to its abandonment in favour of another method of protecting the forests from the baneful influence of grazing. The main drawbacks

of the scheme were the following :—

(*i*) The regeneration obtained during the period of closure, was at times either killed outright, or badly damaged, whenever a fire (which is almost a regular feature of these forests) happened to occur in any recently felled coupe ;

(*ii*) The long stretch of grazing following the period of closure, adversely affected the pasture ;

(*iii*) The practice of forming fairly large annual coupes to keep down the cost of exploitation, and of having the consecutive coupes contiguous to facilitate inspection and fire protection, resulted in closures of extensive areas in certain localities and thus caused much inconvenience to the cattle owners.

In the year 1915, a new leaf was turned in the history of regulation of grazing in the forests of the province. The policy now inaugurated was to have smaller annual coupes and to close these to grazing for shorter intervals, but more often than once during the life of a wood. The sequence of felling was also fixed with due regard to the convenience of cattle owners. The first working plan in which this policy was given effect to was that of the Yeotmal Forest Division, prepared by Mr. Malcolm (the Chief Conservator of Forests, Central Provinces and Berar), grazing under this plan was restricted both in intensity and in amplitude by prescribing a limiting incidence of three acres per head of cattle, and an intermittent closure of five years after every 10 years of grazing. The period of closure was to commence immediately after the felling operations were over. The rotation of these forests is 30 in some felling series and 45 in others, and as the proposed rotational closures were to be given effect to at once throughout the felling series, the former have always contained two, and the latter three, sets of five consecutive coupes closed to grazing. The improvement in the quality of the tree growth and the pastures in these forests, has been simply remarkable. In fact it has opened out a new vista in the otherwise gloomy outlook of the forest officers of the province, who had given up almost all hopes of improving the forest so long as they were also to provide for an intense demand for grazing.

The grazing-closure cycle adopted in the Yeotmal plan was of necessity a tentative one, because nothing was known regarding the optimum cycle that would ensure the safety of tree growth and pasture alike when this plan was drawn up. Even to-day we are none the wiser except that it seems that the cycle tentatively adopted in the Yeotmal forest, if not the ideal, is certainly very nearly so. Fortu-

nately experiments to determine the exact cycle have recently been taken in hand. The results are keenly awaited. But the adoption of rotational grazing closures in other forests need not be delayed till the ideal cycle has been determined.

As, however, the rotation and the grazing-closure cycle which may be considered most suitable for a forest may not be the same as those of the Yeotmal forests, a system must be devised by which Mr. Malcolm's scheme can be applied under the changed conditions. An attempt is made in this note to show how this may be done ; *viz.*, how the sequence of fellings, which determines the sequence of closure, may be arranged for a given rotation and grazing-closure cycle, so as to ensure safety of tree growth on the one hand, and uniform grazing facilities and inexpensive fire protection for all time on the other.

Throughout the note a felling series (*i.e.*, one complete series of age-gradations) is taken as the unit of a forest, and the ideal arrangement of coupes in it is assumed to be that in which the following conditions are simultaneously fulfilled to the utmost extent possible :—

(*i*) The period of closure to grazing starts immediately after the fellings. (A term which includes the final felling as well as the intermediate fellings or thinnings) ;

(*ii*) The sequence of fellings is so arranged that crops come under the axe for final felling when they are just mature, *i.e.*, sacrifice of immature growth or retention of woods after their value increment has culminated is avoided ;

(*iii*) All the villages that have access to the felling series for grazing are afforded adequate grazing at a reasonable distance throughout the rotation ;

(*iv*) Fire protection of areas closed to grazing is not rendered difficult or expensive ; and

(*v*) In any year areas under the various fellings are so distributed that all the consuming centres can obtain their requirements of timber of various sizes and fuel, close at hand.

Condition (*i*), *viz.*, synchronisation of the commencement of the period of closure to grazing, with the end of felling operations is considered essential, (*a*) to safeguard the young plants that come up in greater abundance immediately after the crop is opened up, and (*b*) to avoid confusion amongst the cattle owners, who do not readily understand the propriety of closures if they are started earlier or later. For a felling series that has been regularly worked in the past the distribution of age-classes is fixed, and if the future coupes are to be so numbered as to fully satisfy condition (*ii*), then unless the arrangement automatically secures conditions (*iii*) to (*v*) (which will seldom be the case in practice), these are likely to be seriously upset.

Conversely if coupes are laid out with satisfaction of conditions (*iii*) to (*v*) as the primary consideration, the particular arrangement may entail an appreciable sacrifice of immature growth or in the alternative its retention long after it has attained financial maturity. Obviously the ideal arrangement will be one which involves the least cumulative sacrifice from all points of view. An attempt is made in the following paragraphs to show how this most happy combination of the various factors enumerated above may be secured for specified rotations, grazing-closure cycles, etc.

Let the complete series of age-gradations r, r-1,........1 years old, which will come up for final felling in the 1st, 2nd,........rth year from to-day, be called coupes 1, 2,......r respectively.

I.—UNIFORM ROTATIONAL CLOSURE.

A.—Final felling (F) when the crop is 36 years old ; i.e., $r=36$. *One Intermediate felling or thinning (T) when the crop is* $\frac{r}{2}$; i.e., 18 *years old. Coupes to be closed to grazing for 6 years immediately after each felling ;* i.e., *at any time exactly 12 out of 36 coupes are to remain closed :*

The conditions in any coupe during a whole rotation, commencing from the year immediately following the final felling, *i.e.*, when the crop over it is theoretically one year old, may be represented by the formula :

$$\begin{array}{lcccccc} \Sigma & (6) & 11 & T & (6) & 11 & F \\ \text{Age :---} & \text{1-6} & \text{7-17} & 18 & \text{19-24} & \text{25-35} & 36 \end{array}$$

$$\underbrace{\text{1-6 \quad 7-17 \quad 18}}_{C_1} \qquad \underbrace{\text{19-24 \quad 25-35 \quad 36}}_{C_2}$$

Note.—Figures in brackets indicate the years during which the coupe will remain closed to grazing. T and F represent the years of thinning and final felling respectively (the coupe will be open to grazing in the year of felling). It will be seen that 6 years' closure alternates with 12 years' grazing, the closure always commencing immediately after the felling operations. There are two closure-grazing cycles, C_1 and C_2, each of 18 years' duration in the life of a wood.

The conditions in the entire felling series in the Nth year from to-day, *i.e.*, in the year when coupe N is under final felling, will be as given in the following table :—

TABLE 1.

	I	II	III	IV	V	VI
F.	$\frac{N}{36,\ xii}$	$\frac{N+1}{35,\ xi}$	$\frac{N+2}{34,\ x}$	$\frac{N+3}{33,\ ix}$	$\frac{N+4}{32,\ viii}$	$\frac{N+6}{31,\ vii}$
	$\frac{N+6}{30,\ vi}$	$\frac{N+7}{29,\ v}$	$\frac{N+8}{28,\ iv}$	$\frac{N+9}{27,\ iii}$	$\frac{N+10}{26,\ ii}$	$\frac{N+11}{25,\ i}$
	$\left(\frac{N+12}{24,\ vi}\right)$	$\left(\frac{N+13}{23,\ v}\right)$	$\left(\frac{N+14}{22,\ iv}\right)$	$\left(\frac{N+15}{21,\ iii}\right)$	$\left(\frac{N+16}{20,\ ii}\right)$	$\left(\frac{N+17}{19,\ i}\right)$

	VII	VIII	IX	X	XI	XII
T.	$\frac{N+18}{18,\ xii}$	$\frac{N+19}{17,\ xi}$	$\frac{N+20}{16,\ x}$	$\frac{N+21}{15,\ ix}$	$\frac{N+22}{14,\ viii}$	$\frac{N+23}{13,\ vii}$
	$\frac{N+24}{12,\ vi}$	$\frac{N+25}{11,\ v}$	$\frac{N+26}{10,\ iv}$	$\frac{N+27}{9,\ iii}$	$\frac{N+28}{8,\ ii}$	$\frac{N+29}{7,\ i}$
	$\left(\frac{N+30}{6,\ vi}\right)$	$\left(\frac{N+31}{5,\ v}\right)$	$\left(\frac{N+32}{4,\ iv}\right)$	$\left(\frac{N+33}{3,\ iii}\right)$	$\left(\frac{N+34}{2,\ ii}\right)$	$\left(\frac{N+35}{1,\ i}\right)$

Note.—The numerator indicates the number of the coupe: the arabic numeral in the denominator gives the theoretical age of the crop: and the roman numeral denotes the year of closure or grazing as the case may be, when coupe N is under final felling. The coupes closed to grazing are shown in brackets. When the value of the numerator exceeds (*i.e.*, 36 in the example under consideration) the excess over r will give the number of the coupe. The 36 coupes have been divided into 12 trios designated I, II . . . . . . XII, in the table, the reason for which will be clear from the subsequent paragraph.

Conditions when N = 1 are illustrated in Figure 1. The arrangement of coupes in this figure, however, is purely diagrammatic, and has nothing to do with the arrangement in the forest. The coupes closed to grazing are shown by a black wash, and those under fellings are shaded by diagonal lines.

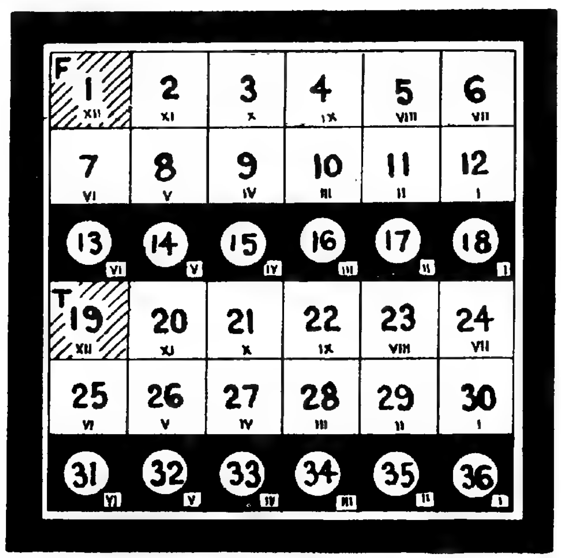


FIG. 1.

For a compact felling series of 5,000—10,000 acres it may safely be assumed that at least $\frac{1}{2}$ (or $\frac{1}{3}$ or $\frac{1}{4}$) is conveniently accessible to a particular group of villages resorting to it for grazing. In other

words it will be sufficient if the felling series could be split up into 2 (or 3 or 4) equal portions, *i.e.*, each containing 18 (or 12 or 9) coupes, in such a way that it will have two-thirds of its area, *i.e.*, 12 (or 8 or 6) coupes open to grazing throughout the rotation. This may be done in the following manner :—

A glance at Table I will show that conditions regarding grazing or closure in the corresponding coupes included in any one pair of trios—

(I, VII) ; (II, VIII) ;..........or (VI, XII)

are identical at any time in the rotation, *i.e.*, the three coupes in any trio, say III, are in the same year of closure or grazing, as the corresponding coupes in the associated trio, *i.e.*, IX. Thus the corresponding coupes N+2 and N+20 of these trios are both in their tenth year of opening, and similarly coupes N+14 and N+32, both in their fourth year of closure. It will further be seen that of the 3 coupes included in each of the trios I to XII *one and only one* coupe remains closed to grazing at any time in the rotation.

Therefore when the felling series is to be split up into 2 (or 3 or 4) groups of coupes to suit the convenience of grazing, any 6 (or 4 or 3) of these trios may be allotted to each group, and exactly two-third of the coupes in it will remain open to grazing at any time during the rotation.

The age-class distribution of the felling series, however, may not be such as to warrant inclusion of a trio as a whole, into a group without undue sacrifice of growth, and to minimise this, shiftings may be necessary. These may be done without any prejudice to grazing facilities in the following manner. As has been shown already the conditions regarding grazing or closure in any coupe, say x, and the coupe which differs from it by 18—the duration of the grazing closure cycle—*i.e.*, coupe x+18, are always the same. Therefore wherever coupe x does not fit in with the age-class distribution, coupe x+18 can be laid out instead ; and the sacrifice of young growth or its retention beyond maturity avoided to a great extent.

Thus any or all of the three coupes x, x+6 and x+12 in any trio, say P, can always be replaced by coupes x+18, x+24, and x+30 respectively of the associated trio P+VI, *i.e.*, the six coupes,

(x or x+18 : x+6 or x+24 : x+12 or x+30)

A B C D E F

can be split up into two trios, each containing *one and only one* coupe from each of the pairs AB, CD and EF in four different ways as under :—

(ACE, BDF) ; (ACF : BDE) ; (ADE, BCF) & (ADF, BCE)

The remaining five pairs of trios, *viz.*,

(P+I, P+VII) ; (P+II, P+VIII) ; (P+III, P+IX) ; (P+IV, P+X) ; & (P+V, P+XI)

containing coupes,

(x+1 or x+19 : x+7 or x+25 : x+13 or x+31)
(x+2 or x+20 : x+8 or x+26 : x+14 or x+32)
....
(x+5 or x+23 : x+11 or x+29 : x+17 or x+35)

respectively, can similarly be split up in pairs of threes in 4 different ways each. Thus a very wide choice is possible ; and the particular combination which involves the least sacrifice can easily be determined.

Other factors that have to be given due consideration in deciding the location of coupes are (*a*) reduction in the cost of fire protection, and (*b*) distribution of the fellings to suit the convenience of the consumers. Coupes closed to grazing are the only ones to be fire-protected and there will always be two sets of these, each containing six consecutive coupes (one being taken as the continuation of 36), *viz.*, (N+30 to N+35) and (N+12 to N+17) when coupe N is under final felling. Therefore to keep the cost of fire-protection low, it will be enough if the consecutive coupes are kept contiguous as far as possible. This can be secured to a very great extent if consecutive trios, I, II,......, are allotted to each group, and too many transpositions are avoided. Lastly to ensure convenient distribution of fellings it will be sufficient if coupes are so arranged that the main felling alternates with the thinning in each group.

A few examples of the arrangement of coupes on the lines suggested are given below. In the illustrations of the resulting arrangement of coupes, the shape of the coupes is only diagrammatic. In practice wherever permanent features are absent, rectangular coupes with North-South and East-West boundaries should be laid out with, as far as possible, their shorter side abutting on the outer boundary of the forests to ensure convenience in demarcation and subsequent check, on the one hand, and avoidance of long stretches of closed area bordering the villages, on the other.

Example 1.—Felling series a compact block with Reserved Forest on two sides, say North and South, and villages in the East and West, *i.e.*, only half of the felling series is conveniently accessible to each group of villages V_1 and V_2.

Figure 2.

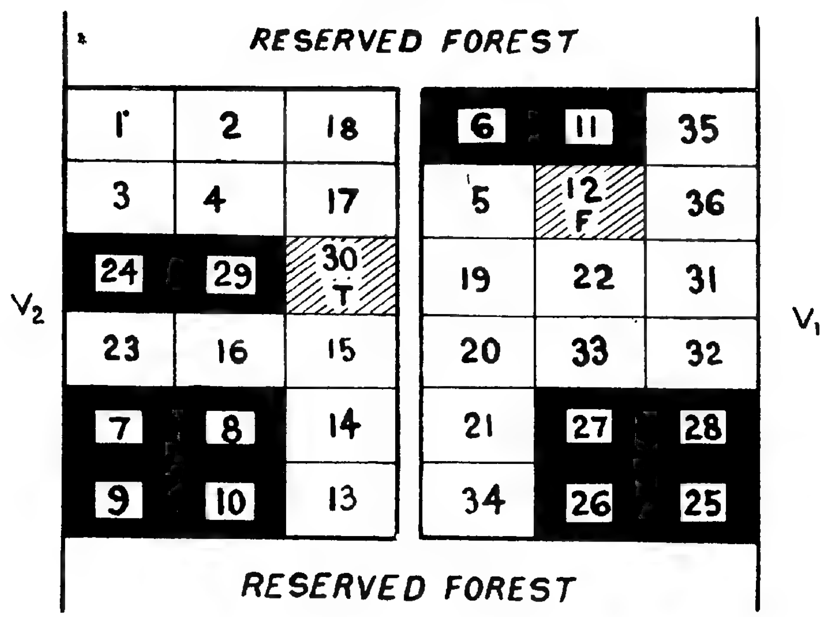


FIG. 2.

Note.—In this and the following two diagrams conditions when coupe 12 is under main fellings are illustrated; coupes closed to grazing and fire-protected are shown with a black wash, and those under fellings are shaded by diagonal lines.

Example 2.—Felling series an isolated block with villages all around it, so that only one-third of the felling series is conveniently accessible to each group of villages V_1, V_2 and V_3.

Figure 3.

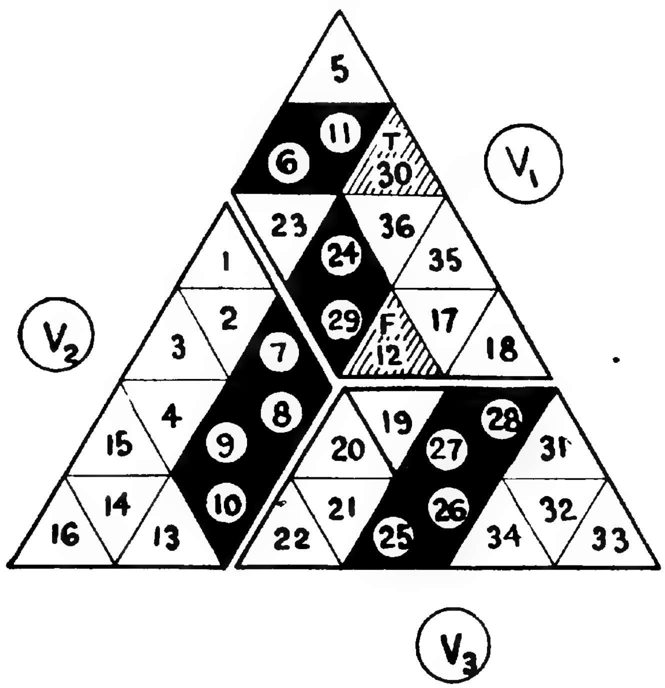


FIG. 3

Example 3.—Felling series in two isolated blocks of which only half is accessible to each group of villages, *i.e.*, there are four groups of villages.

Figure 4.

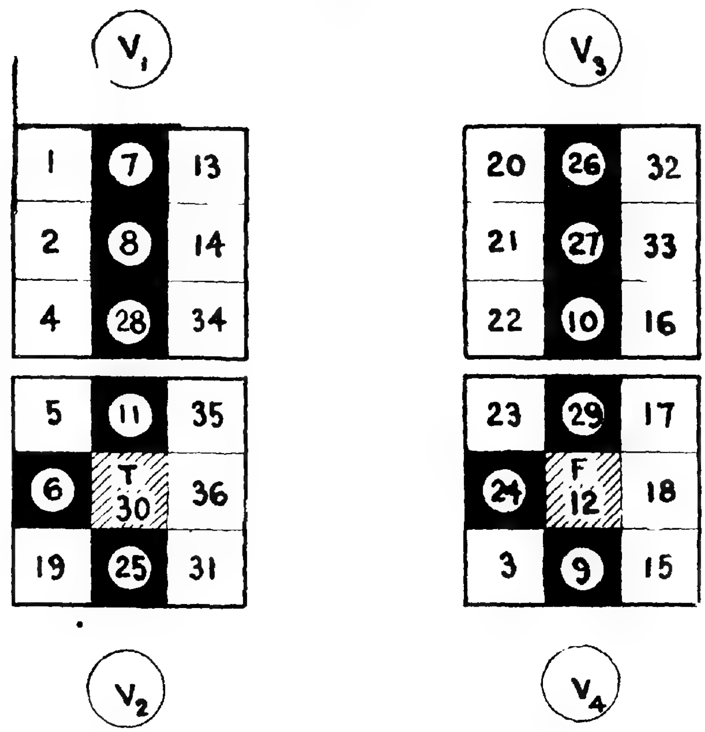


FIG. 4.

B.—Felling Cycle 48 years : ¼ closure uniformly distributed, and two intermediate fellings (T_1 and T_2) as under :—

Σ (4)	11	T1	(4)	11	T2	(4)	11	F.
Age :—1-4	5-15	16	17-20	21-31	32	33-36	37-47	48
	C_1			C_2			C_3	

Here the conditions in the Nth year will be :

TABLE 2.

A	B	C	D
I	II	III	IV
F.—N/xii	N+1/xi	N+2/x	N+3/ix
N+4/viii	N+5/vii	N+6/vi	N+7/v
N+8/iv	N+9/iii	N+10/ii	N+11/i
(N+12/iv)	(N+13/iii)	(N+14/ii)	(N+15/i)

	V	VI	VII	VIII
T_2.—	N+16/xii	N+17/xi	N+18/x	N+19/ix
	N+20/viii	N+21/vii	N+22/vi	N+23/v
	N+24/iv	N+25/iii	N+26/ii	N+27/i
	(N+28/iv)	(N+29/iii)	(N+30/ii)	(N+31/i)

	IX	X	XI	XII
T_1.—	N+32/xii	N+33/xi	N+34/x	N+35/ix
	N+36/viii	N+37/vii	N+38/vi	N+39/v
	N+40/iv	N+41/iii	N+42/ii	N+43/i
	(N+44/iv)	(N+45/iii)	(N+46/ii)	(N+47/i)

It will be seen that each of the quartets I to XII contains *one and only one* closed coupe at any time in the rotation, and the grazing conditions in the corresponding coupes of the associated quartets, *i.e.*, those occurring in the same column in the table, *viz.*

(I, V, IX) ;	(II, VI, X) ;	(III, VII, XI) ; &	(IV, VIII, XII)
A	B	C	D

are identical, so that any coupe x in any quartet, say P, can always be replaced by the corresponding coupes x+16 in the quartet P+IV, or x+32 in the quartet P+VIII. Thus from the 12 coupes in any column A, B, C or D a quartet containing *one and only one* coupe from each triplet of identical coupes, *viz.*,

$$\begin{array}{lll} (x, & x+16, & x+32) ; \\ (x+4, & x+20, & x+36) ; \\ (x+8, & x+24, & x+40) ; \text{ and} \\ (x+12, & x+28, & x+44) \end{array}$$

can be formed in 3^4 or 81 ways. After one quartet has been so chosen, a second (and hence the third) quartet containing one and only one of the remaining 4 pairs of identical coupes can be selected in 2^4 or 16 ways. Thus each group of 12 coupes of the columns A, B, C or D permits of being split up into three quartets in $\frac{3^4\times2^4\times1^4}{1\times2\times3}$

i.e., 216 different ways, and the arrangement which involves the minimum sacrifice can easily be chosen in laying out the coupes. Two examples are given below :—

Example 4.—Compact felling series with three grazing centres V_1, V_2 and V_3 around it.

Figure 5.

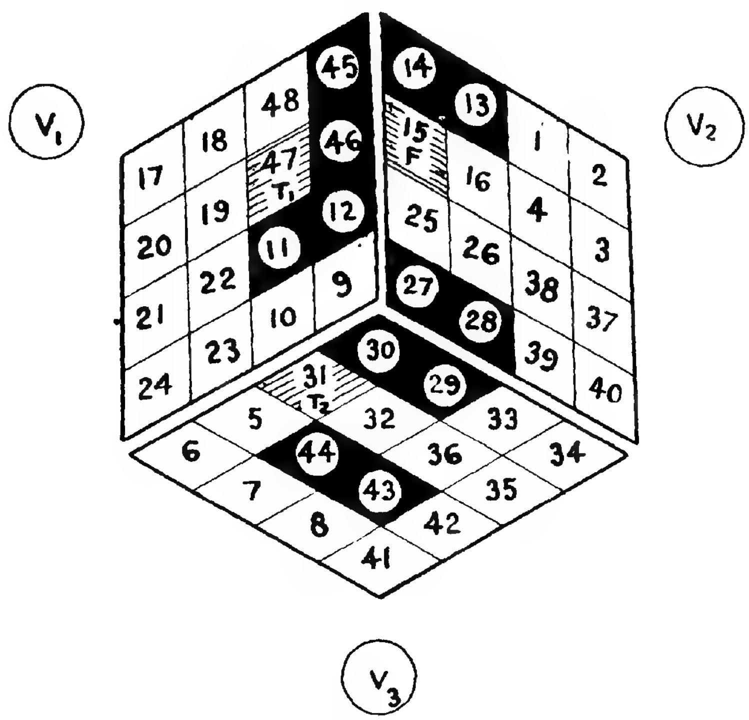


FIG. 5.

Note.—Conditions when coupe 15 is under final felling are illustrated in this and the next figure.

Example 5.—Four grazing centres.

Figure 6.

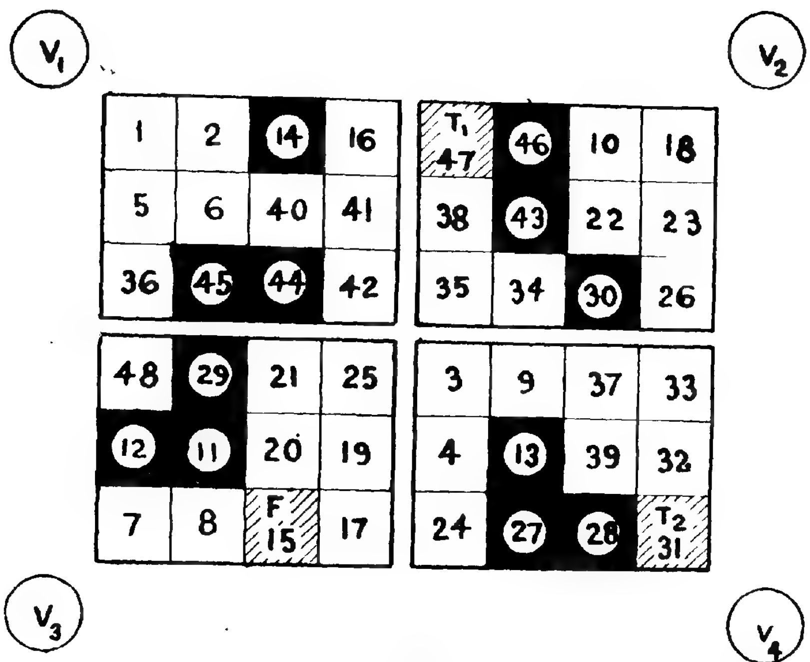


FIG. 6.

C. *Felling cycle* 45 *years; two intermediate fellings and one-third uniform closure as under*:—

Σ (5) 9 T_1 (5) 9 T_2 (5) 9 F.

The condition of interchangeability in this case can easily be worked out as in the previous arrangement. An example showing how the coupes may be apportioned to three centres of grazing,

so that each shall have uniform grazing facilities throughout the rotation is given below :—

Figure 7.

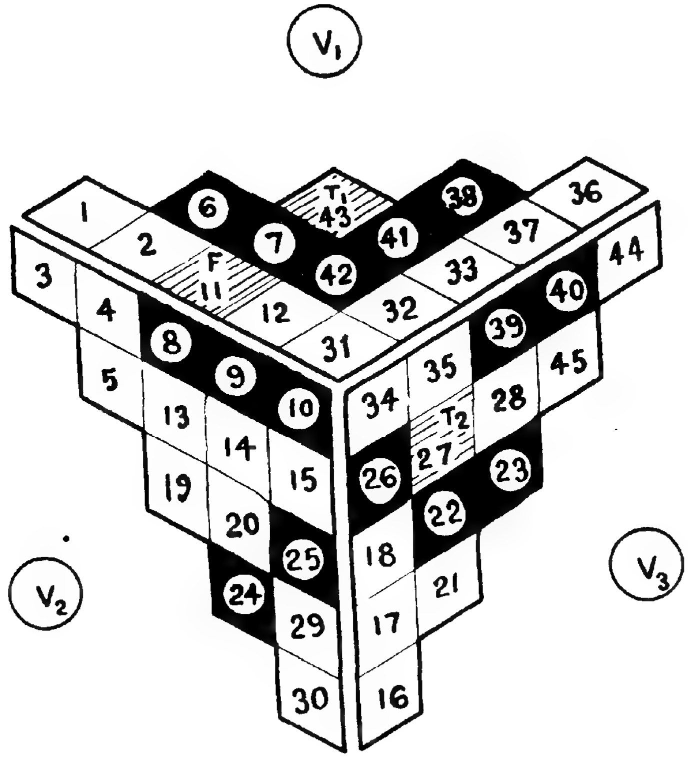


FIG. 7.

Note.—Conditions when coupe number 11 is under final felling are illustrated.

II.—VARIABLE ROTATIONAL CLOSURE.

D.—*Felling cycle* 48 *years, two intermediate fellings and* $\frac{1}{4}$ *closure in three periods of* 5, 4 *and* 3 *years alternating withgrazing for* 11, 12 and 13 *years respectively, as under* :—

$$\begin{array}{lccccccccc} \Sigma & (5) & 10 & T_1 & (4) & 11 & T_2 & (3) & 12 & F. \\ \text{Age :—} & \text{1-5} & \text{6-15} & 16 & \text{17-20} & \text{21-31} & 32 & \text{33-35} & \text{36-47} & 48 \end{array}$$

$$\underbrace{\text{1-5 \quad 6-15 \quad 16}}_{C_1=16} \qquad \underbrace{\text{17-20 \quad 21-31 \quad 32}}_{C_2=16} \qquad \underbrace{\text{33-35 \quad 36-47 \quad 48}}_{C_3=16}$$

Here the conditions in the Nth year will be :—

TABLE 3.

	A	B	C	D
F.—	N/xiii	N+1/xii	N+2/xi	N+3/x
	N+4/ix	N+5/viii	N+6/vii	N+7/vi
	N+8/v	N+9/iv	N+10/iii	N+11/ii
	N+12/i	(N+13/iii)	(N+14/ii)	(N+15/i)
T_2.—	N+16/xii	N+17/xi	N+18/x	N+19/ix
	N+20/viii	N+21/vii	N+22/vi	N+23/v
	N+24/iv	N+25/iii	N+26/ii	N+27/i
	(N+28/iv)	(N+29/iii)	(N+30/ii)	(N+31/i)
T_1.—	N+32/xi	N+33/x	N+34/ix	N+35/viii
	N+36/vii	N+37/vi	N+38/v	N+39/iv
	N+40/iii	N+41/ii	N+42/i	N+43/v)
	(N+44/iv)	(N+45/iii)	(N+46/ii)	(N+47/i)

It will be seen that as the periods of closure after the fellings T_1, T2 and F are different, the number of coupes closed in the columns A, B, C and D is not the same and also alters from year to year. Thus when coupe N is under final felling (F) and therefore coupes N+16 and N+32 under the second (T_2) and first (T_1) thinning respectively the number of coupes closed to grazing, occurring in columns A, B, C and D are 2, 3, 3 and 4 respectively; whereas when say coupe N+2 is under the final felling, and therefore coupes N+18 and N+34 under the second and first thinning respectively, the number of closed coupes occurring in each of the four columns will be exactly three. This variation is due to the fact that the number of years for which a particular coupe remains open or closed to grazing in the three closure-grazing cycles C_1, C_2 and C_3 is not the same.

Throughout the rotation, out of the 4 coupes that remain closed after the first thinning, *one and only one* such coupe occurs in each column. As, however, a coupe is closed for five years after the final felling, always 5 successive coupes are under closure. Of these 5 coupes, those that are in their *first* and *fifth* year of closure, always occur in the same column, and the pair shifts from one column to the next adjacent to it year after year in the cyclic order. Lastly, as a coupe is closed only for three years after the second thinning, there are only 3 consecutive coupes thus closed, and therefore always one

of the four columns must remain without such a coupe. The column that remains vacant changes from year to year. If, therefore, it could be so arranged that the column that contains no coupe closed after the second thinning also always contained the two coupes that are in their first and fifth year of closure after the final felling, there will be *three and only three* closed coupes in each column at any time in the rotation. This is possible if the second thinning is delayed by a year, *i.e.*, the crop is thinned when it is 33 and not 32 years old. For reasons explained in the next paragraph the first thinning should also be delayed for a year, *i.e.*, the crop be thinned when it is 17 and not 16 years old. In other words when coupe N is under final felling coupes N+15 and N+31 and not N+16 and N+32 should be under the second and first thinning respectively. To show the various salient features of the proposed modification, *viz.*

$$\begin{array}{llll} \Sigma\,(5)\quad 11\quad T_1 & (4)\quad 11\quad T_2 & (3)\quad 11\quad F. \\ \text{Age :—}\underbrace{1\text{-}5\quad 6\text{-}16\quad 17}_{C_1=17} & \underbrace{18\text{-}21\quad 22\text{-}33\text{—}33}_{C_2=16} & \underbrace{34\text{-}36\quad 37\text{-}47\quad 48}_{C_3=15} \end{array}$$

the conditions in the Nth year are tabulated below :—

TABLE 4.

	A	B	C	D
F.—	N/xii	N+1/xi	N+2/x	N+3/ix
	N+4/viii	N+5/vii	N+6/vi	N+7/v
	N+8/iv	N+9/iii	N+10/ii	N+11/i
	(N+12/iii)	(N+13/ii)	(N+14/i)	(N+15/xii=T_2
	N+16/xi	N+17/x	N+18/ix	N+19/viii
	N+20/vii	N+21/vi	N+22/v	N+23/iv
	N+24/iii	N+25/ii	N+26/i	N+27/iv
	(N+28/iii)	(N+29/ii)	(N+30/i)	N+31/xii=T_1
	N+32/xi	N+33/x	N+34/ix	N+35/viii
	N+36/vii	N+37/vi	N+38/v	N+39/iv
	N+40/iii	N+41/ii	N+42/i	N+43/v)
	(N+44/iv)	(N+45/iii)	(N+46/ii)	(N+47/i)

Note.—To avoid confusion the ages of the crop over the various coupes have not been indicated. In general, coupe x is (r+1)— x years old and the age of any particular coupe may be mentally computed. In the example under consideration r=48. Thus when, say, coupe 1 is under final felling, *i.e.*, it is 48 years old, the coupes under the second and first thinnings are 16 and 32; and their ages will be (49-16) and (49-32), *i.e.*, 33 and 17 years respectively. Conditions when N=1 are illustrated in Figure 8. The arrangement of coupes is only diagrammatic and has nothing to do with the distribution on the ground.

Figure 8.

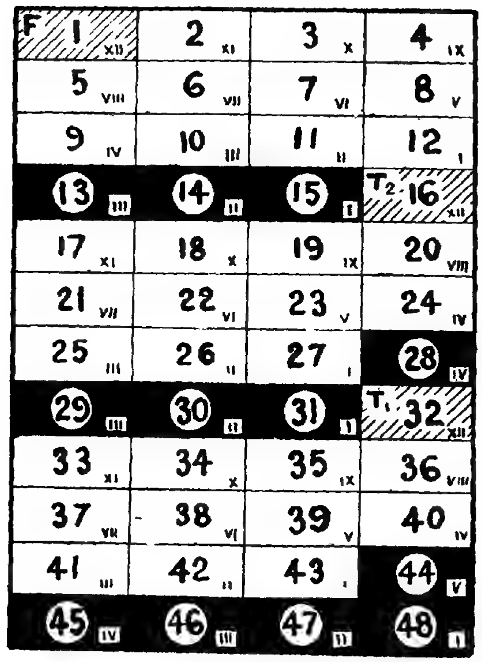


FIG. 8.

The following features may be noted for this arrangement :—

(*i*) Coupes always come under working in their 12th year of opening, *i.e.*, continuous grazing for more than 12 years is avoided ;

(*ii*) Each of the columns A, B, C and D contains *three and only three* closed coupes at any time in the rotation.

Thus the felling series can always be split up into 4 (or 2) groups by taking coupes occurring in any 1 (or 2) column in each, so that there will always be only 25 per cent. closure in each group. Splitting of the felling series into three equal portions, to provide for the convenience of three grazing centres, each with *exactly* one-fourth closure throughout the rotation is not possible ; but division of the felling

series into three portions with 32, 16 and 16 coupes in each so that each portion shall always have exactly 25 per cent. closure is possible.

Shiftings to reduce the sacrifice of immature growth or its retention after the value increment has culminated, are not permissible if the closure in each portion is to be exactly 25 per cent. throughout the rotation, for the obvious reason that the three closure-grazing cycles C_1, C_2 and C_3 are not identical.

In practice, however, slight departures from the above conditions will not matter much, as they will either mean slightly heavier grazing or in the alternative a somewhat longer lead to the cattle in certain tracts. Thus instead of exactly 4 coupes out of 16 remaining closed in any third of the felling series, if at times 3 or 5 closed coupes are permissible, some shiftings are possible as under :—

The coupes closed in the Nth year are :

(N+14,	N+30,	N+47)	..	In their	1st	year	of closure.
(N+13,	N+29,	N+46)	..	,,	2nd	,,	
(N+12,	N+28,	N+45)	..	,,	3rd	,,	
	(N+27,	N+44)	..	,,	4th	,,	
		(N+43)	..	its	5th	,,	

Or arranging them according to the years after which they will reopen :—

(N+12,	N+27,	N+43)	..	Opening after	1	year.
(N+13,	N+28,	N+44)	..	,,	2	years
(N+14,	N+29,	N+45)	..	,,	3	,,
	(N+30,	N+46)	..	,,	4	,,
		(N+47)	..	,,	5	,,

It will be seen that coupes differing by 15 or 16 are in the same year of closure, *more or less*. In other words coupe x may be replaced by x+15 or x+16 without seriously disturbing the grazing arrangements. Coupes x and x+16, however, are already in the same column, and therefore the only exchanges possible are between (x and x+15) or (x and x+31). An example showing the effect of such interchanges is given in Figure 9.

Figure. 9.

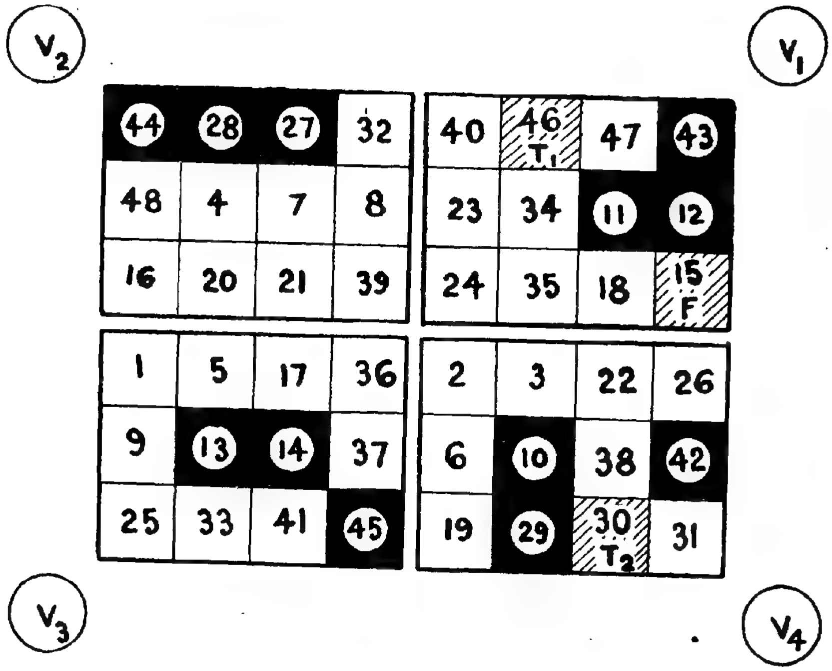


FIG. 9.

Note.—Conditions when coupe 15 is under final felling and therefore coupes 30 and 46 under the second and first thinnings respectively are illustrated.

The manner in which a felling series may be split up under other rotations, grazing-closure cycles and intermediate fellings, such as—

Σ (5) 12 T_1	(5) 12 F;		
Σ (3) 8 T_1	(3) 8 T_2	(3) 8 F;	
Σ (4) 7 T_1	(3) 8 T_2	(2) 9 F;	
Σ (3) 6 T_1	(3) 6 T_2	(3) 6 T_3	(3) 6 F;
etc.	etc.	etc.	

may similarly be worked out.

III.—Practical Hints.

Laying out of coupes will be much simplified if the following procedure is adopted :—

Suppose the rotation, closure-grazing cycle, and the intermediate fellings decided upon are—

Σ (4) 11 T_1 (4) 11 T_2 (4) 11 F, *i.e.*, r=48.

Then 48 *plaques* or tickets each about one* inch square should be prepared out of a fairly stiff cardboard and coloured and numbered as shown in Figure 10.

*Here it is assumed that the maps on which coupes are to be laid out are drawn on a scale of 4″=1 mile, and that the coupes are roughly 100—200 acres in area. K.P.S.

Figure 10.

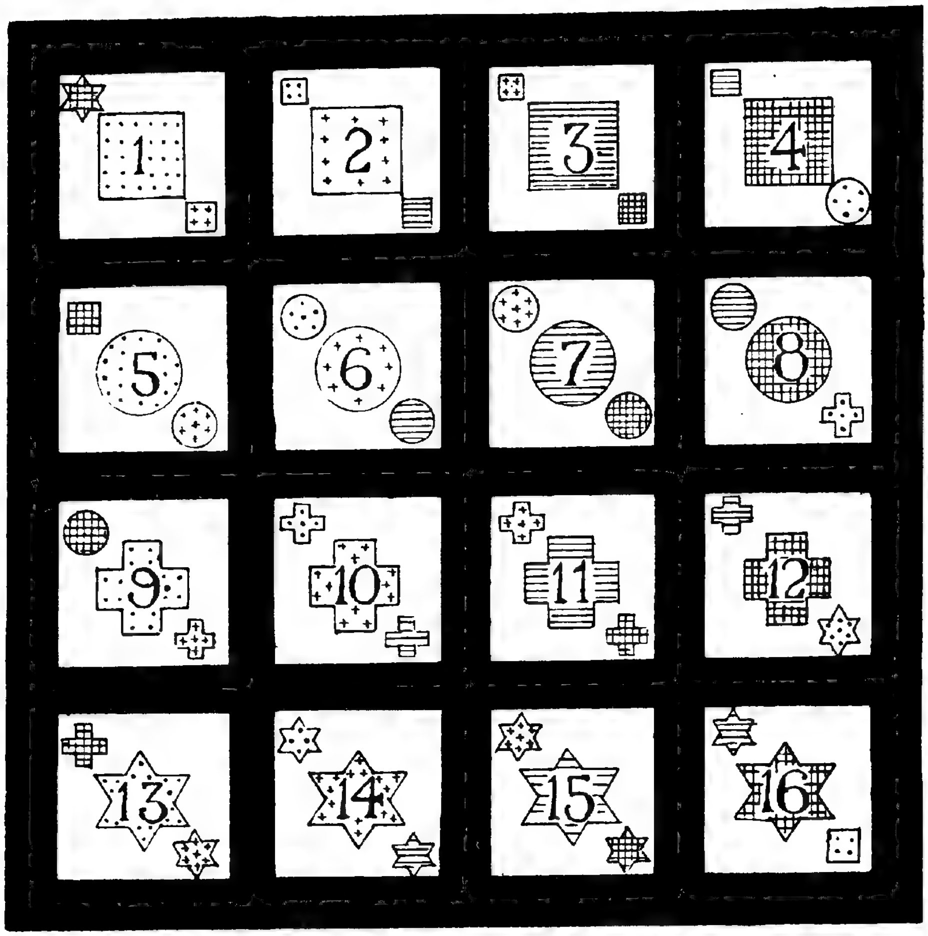
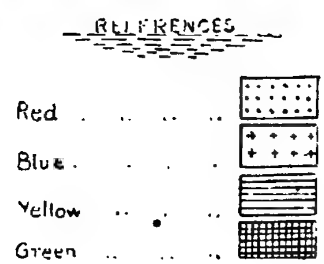


Fig 10



Only tickets numbered 1 to 16 are shown in the illustration. Tickets 17 and 33 will bear the same design and colour as 1 ; 18 and 34 as 2 ; etc. In general x+16 and x+32 will be similar to x.

These tickets should then be spread over the map so as to fit in best with the age-class distribution of the felling series, taking care, however, to see that as far possible successive coupes are kept adjacent to one another. This may at times lead to felling some of the crop a few years, say up to 5, before it is fully mature, or its retention for an equal period after it has attained the most profitable size. The small sacrifice thus involved will be more than compensated for by the advantage of convenience of grazing and fire-protection that would be secured thereby.

The resulting closure during the rotation should then be studied, and if it is found unsatisfactory suitable shiftings should be made according to the methods indicated in the foregoing paragraphs. A study of the colour and the design of the ticket will show that the three coupes (1, 17, 33) ; (2, 18, 34) ; ....(x, x+16, x+32) ; ...... which always close (or open) simultaneously, bear the same *design and colour* ; and that each ticket shows in the top* left hand corner and the bottom right hand corner a miniature design and colour of the coupe that closes (or opens) a year before and after, respectively. Thus coupe 16 is shown inside a green star, and so are also coupes 32 and 48. On the top left hand corner of these is shown a miniature yellow star, and on the bottom right hand corner a red square, these being the colours and designs of the coupes that will close (or open) in the previous and the subsequent years respectively. These are coupes (15, 31, 47) and (17, 33, 1) respectively; the former being shown in yellow stars and the latter in red squares. The reasons for having the distinguishing designs (square, circle, cross and star) and colours †(red, blue, yellow and green) in the manner indicated in Figure 10 will be obvious when closures throughout the rotation for a particular arrangement of coupes are studied on the map. Thus say

*To avoid confusion due to the symmetry of numbers 1, 11 and 8, or the fact that an inverted 6 may be read as 9, it would be better if the miniature of the preceding coupe is shown in the bottom left hand corner, so that the top corners (left and right) are always left blank.—K.P.S.

† In Figure 10 colours have been omitted to reduce costs—Ed.

in the year when coupe 10 is under final felling, the coupes that will be closed to grazing will be (9, 8, 7, 6); (25, 24, 23, 22); and (41, 40, 39, 38) *i.e.*, all coupes shown in red crosses, and green, yellow and blue circles ; and the conditions of closure in the whole felling series can be visualised at a glance.

Any suggestions to further improve the scheme outlined above will be highly appreciated.

London, 10th October 1934.

SKIDDING PAN MADE FROM BUTTRESS OF A TREE.

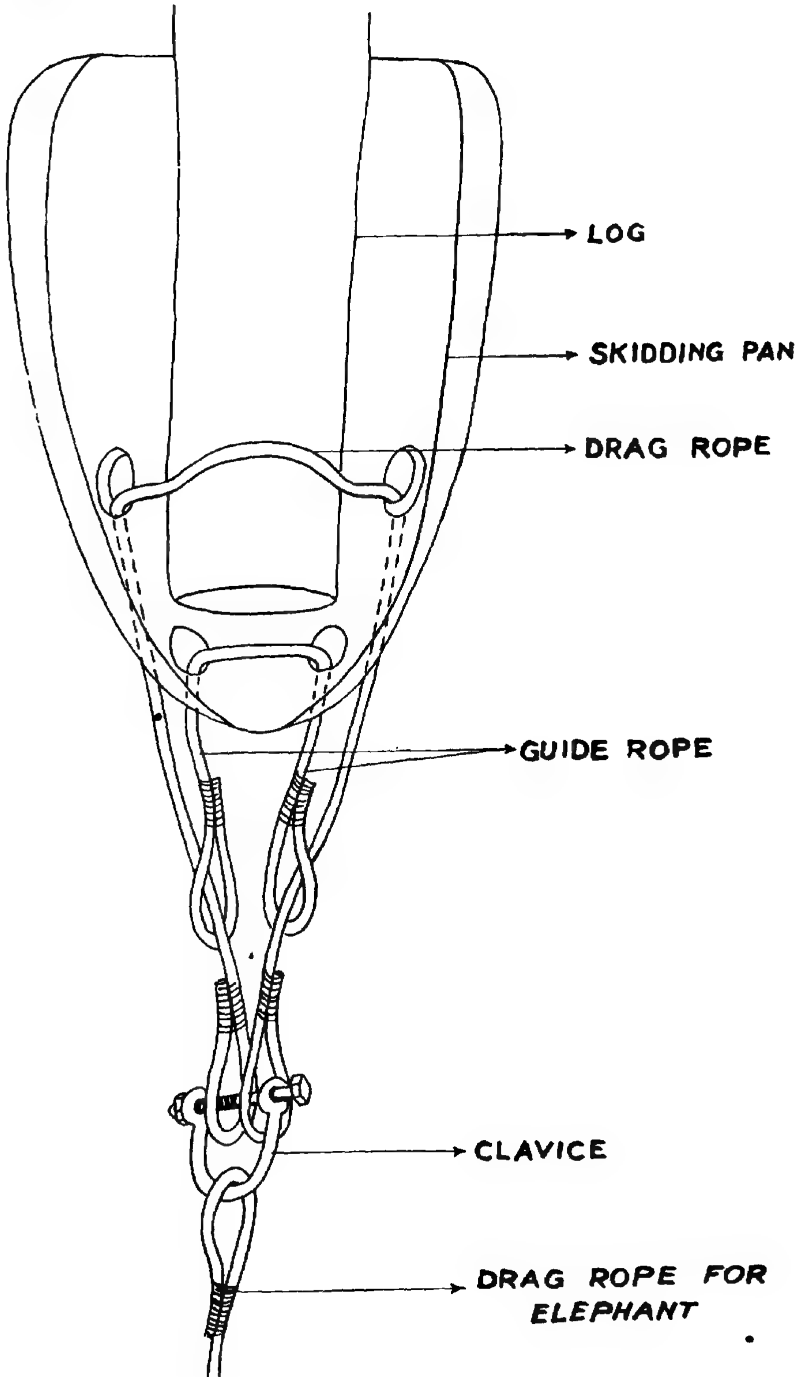
By R. I. Macalpine, D. F. O., Chittagong Hill Tracts.

"Necessity is the mother of invention" and when necessity arises in the "wilds" invention takes queer shapes.

An attempt was being made in the early part of the rains of 1934 to make use of a pair of elephants for timber dragging purposes. Saddles after Sanderson's pattern were constructed locally and work started, but it was found that when the log was dragged under wet conditions the clayey soil offered considerable resistance and much of the elephants' energy was wasted in overcoming it. Placing "rollers," shaping the ends of the logs, and notching for the rope took too much time and labour, and something had to be thought out quickly.

We are the proud possessors in this Division of a tractor, and part of its equipment consisted of a magnificent chromium steel skidding pan valued at somewhere near Rs. 1,000 but weighing about half a ton. This suggested a skidding pan which would be suitable for elephants. The end of a dugout was first suggested but this was abandoned as being too frail for the job.

In the course of an evening walk it suddenly struck me that some use might be made at last of the hitherto useless *civit* (*Swintonia floribunda*), as a particularly large specimen had a fine concave buttress which Providence had obviously designed for just such a purpose as a skidding pan.



PAN MADE FROM THE BUTTRESS OF A TREE.

Willing hands were soon at work and after a certain amount of "trial and error" the finished product as sketched herewith (Plate 16) was evolved.

The log is dragged on to the pan by elephants and the noose of the drag rope is placed over the end some distance back from the face of the log. The drag rope of the elephants is then attached to the clavice and all that remains to be done is for the elephant to pull. The strain tightens the wire rope on the log which is thus firmly held.

The guide ropes were found necessary to add further rigidity and to keep the drag rope towards the centre of the pan. They also have a tendency to raise the fore end of the pan thus helping it to ride over obstructions.

All ropes are pieces of rejected wire rope from the tractor.

So far some 7,000 c. ft. of timber have been transported by this pan and there is little or no sign of wear. Gross cost Rs. 5 including labour and value of wire rope, etc.

THE EFFECT OF BURNING ON THE RATE OF GROWTH OF MEDIUM QUALITY SAL COPPICE.

By F. C. Osmaston, I. F. S.

In order to study the effect of burning debris left in a sal coppice coupe after felling, two experimental plots were laid out in the Sambalpur Division in February 1925 and another similar pair a year later. Both pairs of plots were situated in sal forest of about quality III (typical of the Sambalpur Coppice coupes). The soil in both was a moderately deep sandy loam with a percentage of fine clay overlying lateritic, phyllitic and micaceous schist rock. The monsoon climate is typical of eastern central India, the rainfall being about 50 inches per annum, the great majority of which falls between June and September. The dry weather is hot and severe, lasting until mid June while very little rain falls from November to June. Frost is unknown.

Both pairs of plots are on nearly flat land. Before felling, the sal crop was fairly even aged from 9 to 12 inches diameter, mixed with a few

species such as *Terminalia tomentosa* and *Eugenia jambolana*. The undergrowth was very scanty consisting of a few *Ixora parviflora*. To the eye each pair of plots seemed comparable, but no figures to show comparability have been recorded.

In each pair of plots the treatment was similar. They were felled and the produce extracted as if they were being worked as an ordinary coppice coupe. In each pair of plots one plot was then burnt in April, the other plot being left unburnt. (*Note.*—Plots 7 and 8 were laid out in February 1925 and plot 7 burnt in April 1925. Plots 28 and 29 were laid out in February 1926 and plot 28 burnt in April 1926.) The crop in each plot was then allowed to grow up and heights and diameters of the sal were periodically measured.

The results of these measurements are given below :—

Expt. Plot Nos.	D. b. h. (ins.).			Height (feet).			
	1927	1928	1933	1926	1927	1928	1933
7 (burnt)	1·4±·04	1·9±·07	3·3±·12	5·1±·18	8·4±·26	10·7±·35	24·4±·65
8 (unburnt)	1·5±·06	2·0±·04	3·3±·13	6·4±·21	9·4±·23	11·1±·36	24·4±·74
Difference	·1±·07 Not significant.	1±·08 Not significant.	*Nil*	1·3±·28 Significant.	1·0±·35 Significant.	·4±·50 Not significant.	*Nil*
28 (burnt)	..	1·6±·08	3·6±·19	..	6·6±·26	7·6±·25	24·3±·107
29 (unburnt)	1·2	1·8±·11	2·8±·23	..	8·1±·45	8·4±·32	17·6±1·30
Difference	..	·2±·14 Not significant.	·8±·30 Significant.	..	1·5±·52 Significant.	·8±·41 Not significant.	6·7±1·68 Significant.

As there is no data to prove initial comparability it is not safe to draw rigid conclusions. But the replication of the plots gives the results some value.

The figures seem to show that in the 1st and 2nd years the diameter growth in the unburnt plots was greater than in those burnt, but not significantly. But after the 7th and 8th years the diameters in the burnt plots not only equalled those in the unburnt plots but actually exceeded them significantly in plot 28. Exactly the same relation is shown for height growth.

Miri chieftain wearing cane hat with fringe of bear's fur.

The Aba Rani (left) with her daughter-in-law.

A group of Monbas.

A group of Khoas.

As stated above no conclusive results can be claimed, but it would appear that burning results in an initial discouragement to the diameter and height growth of quality III sal, but that this discouragement is more than overcome in later years.

THE CONIFERS OF THE BALIPARA FRONTIER TRACT, ASSAM.

By N. L. Bor, I.F.S., Assam.

That area of the Eastern Himalaya known as the Balipara Frontier Tract covers an enormous stretch of country exhibiting every variety of climate from that of the sweltering plains of Assam to the Arctic climate of the eternal snows. Its northern boundary is the lofty Sela range which sweeps north-eastward from the Tibet-Bhutan border and divides the Balipara Frontier Tract from Tibet proper. It contains several peaks over 21,000 feet in height. Several travellers, Bailey and Moreshead, Kingdon Ward, etc., have crossed the Sela pass into Tibet but the southern slopes to the east are unexplored.

The southern boundary marches with the northern boundaries of the Darrang and Lakhimpur districts of Assam. The Subansiri river forms the eastern boundary while the eastern boundary of Bhutan limits the Frontier Tract to the west.

The flora of this section of the Eastern Himalaya was practically unknown up to recent times. The writer, as Political Officer, has made large collections which are now being examined in the Royal Botanic Garden, Sibpur, with the object of removing this lacuna in our knowledge of the flora of this area.

The present paper aims at giving some account of the conifers found in this area which in some cases present features of unusual interest.

Configuration of the ground.—The area is mountainous and west of the Bhorelli river the trend of the ranges is east and west. The main feature of this section is the mountainous mass, reaching 10,727 feet in height known as Piri, which stands close to the plains. North

of Piri the east and west ridges are lower, some 7,000 to 8,000 feet, until the outlying spurs of the Sela range are reached.

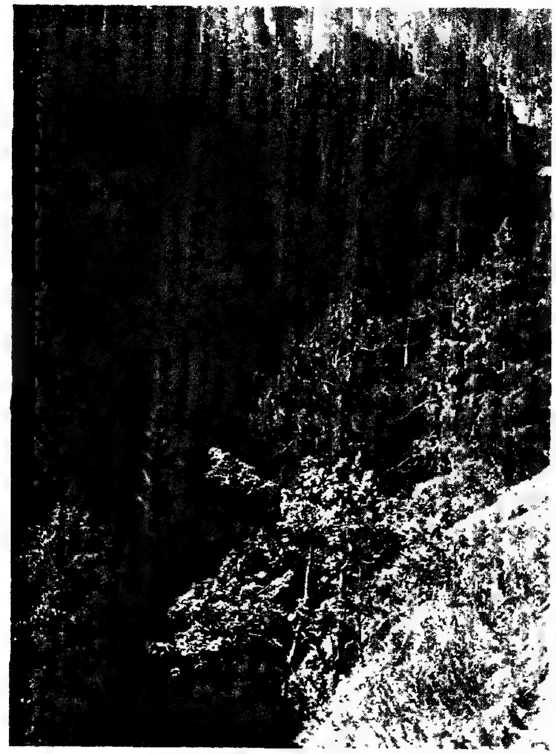
East of the Bhorelli the ridges sweep in a north-easterly direction but the symmetry is broken by a large mountain, 12,000 feet in height, from which spurs radiate like the spokes of a wheel. Further to the east is a remarkable bowl shaped valley at an altitude of 6,000 feet, surrounded by hills which rise another 1,000 feet above it. The inhabitants of this bowl are known as Apa Tanangs and differ markedly from their neighbours in dress and speech.

Climate.—The rainfall of the area is governed by the monsoons of which there are two. From June to September the south-west monsoon operates and deposits the bulk of the annual rainfall in these months. The annual rainfall of the plains is about 90 inches, but when the moisture-laden winds strike the foot-hills, the rainfall is far heavier and reaches 200 inches at the base of the foot-hills. It is still heavier higher up and even 250 inches has been recorded on Piri La, 9,500 feet, during the rainy months. The rainfall is heavy far within the hills when low hills only stand in the way. Piri, however, which presents 10,000 feet of steep forest covered slopes to the force of the monsoon has a remarkable effect upon the rainfall. As has been stated 250 inches have been recorded on Piri but in the valley to the north of this mountain only 60 inches are deposited. The discrepancy has a remarkable effect upon the vegetation and upon the inhabitants. In fact, the inhabitants cannot count upon grass for their cattle after November and the whole tribe migrates *en masse* over Piri to the plains where they remain until March or April.

For the remaining months the dry north-east monsoon is active. A little rain is usual early in the year but for the most part the climate is dry.

Snow lies on the northern slopes of Piri during the winter months but is unusual to the south ; in 1932, however, an exceptionally heavy fall of snow occurred and was visible from the plains for several days. Snow is not unknown at lower elevations and some years ago a column of coolies and sepoys was caught in the hills at 6,000 feet by a severe

Group of Eastern Daflas with Apa Tanang woman behind.



Cupressus torulosa growing in close stand with some Pinus excelsa 15,000′.

Western Daflas.

Tsuga brunoniana on the Piri La 9,500 feet. Foreground Hydrangea altissima and Osmanthus fragrans.

snow storm which nearly led to disaster. Many of the coolies arrived in camp with frost-bitten feet.

Hail storms, too, are very common in February and March and continue for days.

Geology.—The outer foot-hills are formed of tertiary sandstones, a rock that slips easily and accounts for the precipitous nature of the country. In the hills schists, slates and shales are common and the Tenga valley is formed almost entirely of quartzites and limestone.

Inhabitants.—The area is inhabited by an amazing number of tribes. From west to east are to be found Sherchokpas, Sherdukpen, Tembangias, Khoas, Akas, Mijis, Miri Akas, Daflas, Apa Tanangs and Miris, all differing in language, custom and dress.

The western tribes are peaceful and are well disposed to us. The Daflas and Apa Tanangs are, however, inclined to be truculent and it is impossible to tour in their country without an escort.

Species of Conifers.

Pinus excelsa, Wall.—A tree which occurs in two places only. The Tenga valley in the west and the Apa Tanang country to the east. The places are about 150 miles apart.

Tenga valley.—In this valley the climate is dry, rainfall about 60 inches and the soil derived from quartzites and limestone. The tree seems to flourish between 5,000 and 9,000 feet. I have seen it growing at 3,500 feet near Jamiri and there are several trees in the compound of the Political Officer at Chardwar, 300 feet.

In its natural habitat it grows to a large size and trees over 100 feet in height with a girth 8 feet are not uncommon. Planted in the plains it does not exceed 30 feet.

In the Tenga valley the associated trees are *Populus ciliata, Quercus griffithii, Photinia notoniana, Corylopsis himalayana, Rhododendron arboreum, Pieris ovalifolia, Fraxinus floribunda, Deutzia intermedia* and others. *Verbascum thapsus* is very common as are the grasses *Pogonatherum saccharoideum, Cymbopogon nardus* and *Andropogon assimilis.*

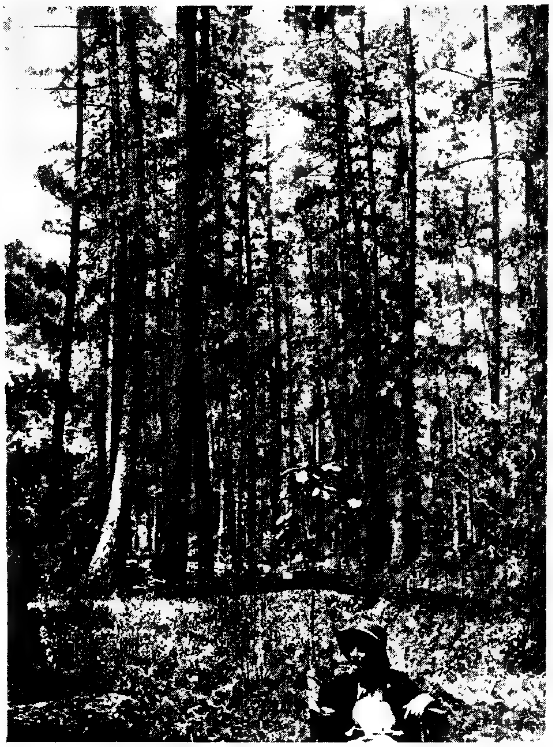
The regeneration is very satisfactory on bare areas if protected from fire.

Apa Tanang Country.—Here the rainfall is much higher and the soil derived from Himalayan gneiss. The elevation is 6,000 to 7,000 feet.

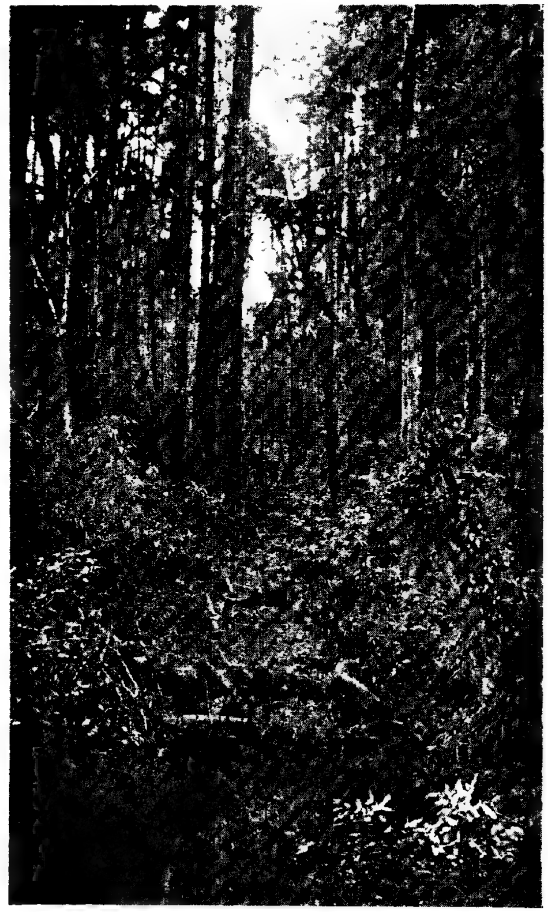
Pinus excelsa reaches magnificent proportions and one tree measured was 150 feet tall with a girth of 14 feet. Associated trees are *Acer niveum, Acer oblongum, Prunus nepalensis,* several species of *Quercus, Myrica nagi, Myrsine capitellata, Illicium griffithii, Turpinia nepalensis* and many others. The undergrowth is dense and consists of many species of which the following are common : *Phlogacanthus guttatus, Lasianthus biermanni, Brachytome wallichii, Peliosanthes macrophylla, Aneilema thomsoni,* etc. *Arundinaria sp.* forms dense thickets. The wood of this pine is used largely by the Apa Tanangs as fuel and for building material.

With regard to this tree I recorded the following note in my diary at the time of my visit in 1933 : "The most striking feature of this valley is the fact that the pine grows pure on the inner slopes only of the bowl and pine trees are not found beyond the lip. On all sides the evergreen forest is apparently encroaching upon the pine as is evidenced by the fact that large numbers of dead pine trees can be seen emerging high above the evergreen forest on the inner side of the lip. A meticulous search in the pure pine forest failed to reveal even one pine seedling and it is obvious that the pine seed cannot germinate and develop in the present conditions. It seems to me as if this pine is the remnant of a very large area of pure pine which is slowly dying out. Anyway it is clear that the *Quercus—Michelia—Acer hylium* is advancing upon it and will eventually prevail. This view is confirmed by certain of the Apa Tanangs elders who told me that the area under pine has decreased even within their time and that their forefathers had come to the same conclusion as that outlined above and had as a consequence with considerable foresight ordered the tree to be raised in plantations."

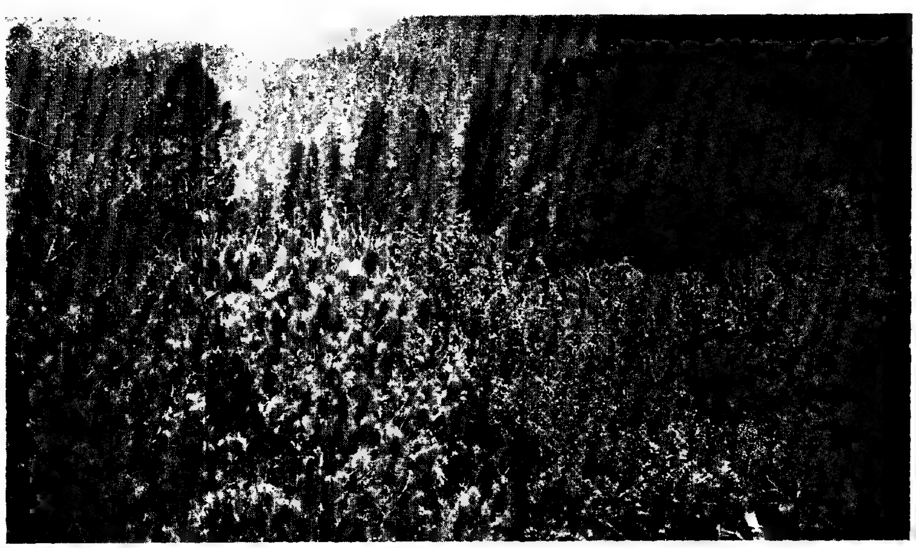
I saw some of the plantations and they are extraordinarily good. Seed broadcast on hoed ground and the area fire protected gives excellent results.



A stand of pure Pinus excelsa in the Tenga Valley. Trees 150 feet in height. The undergrowth is sparse and burns annually.



Pinus excelsa on the Apa Tanang country, the undergrowth is dense evergreen 7,000 feet.



Natural regeneration of Pinus excelsa in foreground, 7,000 feet.

Pinus longifolia, Roxb.—This pine grows pure in the Bhorelli valley between 1,500 feet and 6,000 feet. It is found about 50 miles from the plains where the monsoon begins to lose its force. The soil is derived from tertiary sand stones at the lower elevations and mica schist and gneiss higher up. The forests of *Pinus longifolia* are remarkably pure and the tree reaches a large size, specimens over 100 feet and 6 feet in girth are by no means uncommon. I have no notes of associated species and undergrowth.

The Akas and Sherdukpen use the resin of this tree to smear upon their lips which prevents them cracking in the cold air. The Mijis, Miri Akas and Akas plant the tree for ornament close to their villages.

Abies delavayi, Franchet.—The tree grows pure over considerable areas on the northern slopes of Piri between 9,000 feet and 10,727 feet. Its home is in Szechuan, China, and its presence in Assam is an interesting new record.

The tree grows in remarkably pure stands and confines itself to the northern slopes. It does not grow very tall and the longest seen were scarcely 70 feet with a girth of 6 feet.

Associated trees include *Rhododendron falconeri*, *R. barbatum*, *R. hodgsoni*, *R. fulgens*, *R. keysii*, *R. maddeni*, *Pieris ovalifolia* and *Litsaea sericea*. *Arundinaria aristata* is very common in this forest and is the chief food of the large herds of elephants which live on Piri during the rains.

Abies webbiana, Lindl.—The writer has not collected any specimens of this species but Smythies who visited this area in 1921 recorded its presence. There is no reason why it should not occur as it has been reported on several occasions in Bhutan 20 miles to the west.

Picea spinulosa, Griff. Syn. *P. morindoides*, Rehder.—Captain Nevill, I. P., when on a journey in 1915 recorded and photographed this tree on the Sela pass 14,000 feet.

Tsuga brunoniana, Carr.—A tall and very conspicuous tree common in Piri from 8,000 to 10,000 feet. It seems to prefer small

eminences rising from the ridge proper and grows pure in such situations. The crowns of isolated trees are always blown away to the north-east by the force of the south-west monsoon. Trees over 100 feet tall are common.

Associated trees are *Quercus pachyphylla*, *Q. spicata*, *Prunus nepalensis*, *Rhododendron falconeri*, *Rhododendron barbatum*, *Litsaea sericea*, and *Magnolia campbellii*. In the undergrowth are found *Illicium griffithii*, *Taxus baccata*, *Hydrangea altissima*, *Osmanthus fragrans*, and various species of *Symplocos*. Mosses, especially *Sphagnum acutifolioides*, are very conspicuous on the soil surface.

Cupressus torulosa, Don.—The tree grows naturally on the limestone rocks of the Tenga valley and grows to large dimensions. It is occasionally planted elsewhere principally in the neighbourhood of Buddhist temples and does well on a variety of soils.

In the Tenga valley its principal associates are *Quercus griffithii*, *Pinus excelsa* and *Rhododendron arboreum*. The forest is very open and shrubby vegetation is absent. Conspicuous herbs are *Saxifraga ligulata*, *Verbascum thapsus* and *Gerbera piloselloides*. Common grasses are *Cymbopogon nardus* and *Andropogon assimilis*.

Podocarpus neriifolia, Don.—The tree is very common on the outer foot-hills in the area of greatest rainfall about 5,000 feet. The largest tree seen was 50 feet tall with a girth of 3 feet. Associated trees are species of *Quercus*, *Castanopsis*, *Engelhardtia* and *Eugenia*. The undergrowth is dense and such species as *Baliospermum corymbiferum*, *Strobilanthes boerhaavioides*, *Sauropus macrophyllus*, *Popowia hookeri* and others flourish.

Podocarpus latifolia. Wall.—This tree was encountered on one occasion only in the Western Dafla country at 5,000 feet in the same type of forest as that outlined above.

Taxus baccata, Linn.—A short squat tree very common about 9,000 feet. Some of the trees of this species on the Piri La are of immense girth and age. Frequent is the *Rhododendron—Tsuga—Abies hylium*.

Cephalotaxus griffithii, Hk. f.—A very common small tree found everywhere between 3,000 feet and 5,000 feet in the same type of forest as that in which *Podocarpus neriifolia* occurs.

Cephalotaxus mannii, Hk. f.—A small tree, some 30 feet in height, with smooth bark and pendulous branches. Only met with once in the Dafla Hills near Pakke at 4,000 feet. It was growing in the same type of forest as that mentioned above and was surrounded by seedlings of all ages.

THE RATE OF SPREAD OF LANTANA IN CHAMBA.

BY R. N. PARKER, I.F.S.

When I was in Chamba State in 1919-20 I noted that *Lantana camara* had extended around Chamba town for 1 mile up the valley, 3 miles down the valley and about 500 feet vertically up the hill-sides from the Ravi which here is at an elevation of 3,000 feet. The distances up and down the valley were reckoned along the roads to Rakh and Sundla respectively. On revisiting the State in October 1934, I noticed that *Lantana* extended $4\frac{1}{3}$ miles down the valley from Chamba—an extension of $1\frac{1}{3}$ miles in 14 years. Up the valley it appears to stop quite close to the 3rd mile stone from Chamba—an extension of 2 miles. As regards the vertical limit of 500 feet above the river I could not detect any extension.

The limit of *Lantana* down the valley is very abrupt now as it was 14 years ago. On approaching Chamba within a chain or two of the first *Lantana* plant being noticed, it becomes the commonest plant on the hill sides. This used to be also the case up the valley but it is not so now. In this direction the spread has not been in the direction of the road. *Lantana* has spread far more rapidly on the heavily grazed flats on the edge of the river and from them it has spread up the hill side towards the road which has been reached in places. The limit of *Lantana* up the valley from Chamba is therefore rather indefinite and it is not continuous as far as the 3rd mile stone as it appears to stop and may not be seen for 200 or 300 yards and then starts again.

The spread of *Lantana* is due mainly to heavy grazing. This by destroying all competitors leaves the field free for *Lantana* which together with *Adhatoda vasica*, *Cassia occidentalis* and *tora* takes complete possession of the ground. In places a few stinging nettles persist and in the monsoon *Mirabilis jalapa* springs up if the cover is not too dense.

Birds evidently assist in the spread, as on the edges of the *Lantana* area seedlings tend to be found under trees ; just the place where seeds would be dropped in greatest quantity. Birds alone, however, do little to spread the plant as I have never seen a specimen more than 100 yards or so from the heavily infested area. If grazing round the edge of the *Lantana* area were stopped the further spread of *Lantana* would be slow and possibly would stop completely. It seems probable that as the *Lantana* spreads further and further from Chamba the rate of spread will decrease as it will come to areas less overgrazed than those around Chamba.

GOALPARA FOREST DIVISION, ASSAM.

By R. N. De, I.F.S.

Situated along the foot of the outer hills of the Bhutan Himalayas, the Goalpara division comprises chiefly of an uninterrupted belt of forest 77 miles long and 10 miles broad, between the Sankosh on the west and the Manas on the east. The forest adjoins Bhutan all along the northern boundary of the division which is also the northern limit of the province of Assam here. The boundary line was surveyed and demarcated by the Survey of India a few years back by putting iron pillars at intervals, but the depredations of wild elephants have been such that hardly a pillar remains intact. A 25 feet line is cleared every three years by the Forest department, but the growth of the jungle is so heavy that it is not unusual for one to stray into the Bhutan forests near the boundary. Wild elephants retire into the Bhutan hills in summer and come down again in the plain forests of Goalpara in winter when the paddy is ripe. And for success in elephant-catching operations indeed, a joint *khedda* with Bhutan is essential. The civil district is stituated between 89° 50′ and 91° East Longitude and 26° 40′ and 26° 20′ North Latitude.

The forests occupy a gently sloping plateau which is about 1,000 feet high in the Bhutan border on the north and gradually dwindles down in the plains on the south to about 250 feet within a distance of some 20 miles. The northern part of the plateau forms the commonly known Bhabar tract of our *sal* forests. It is a waterless region and very great difficulty is felt in working our best *sal* forests situated here. Wells dug up to 80 feet have proved a failure. The formation is a conglomerate consisting of rounded boulders and pebbles of quartzite, sand-stone, slate and gneiss washed down by water from the higher hills and deposited in these regions which did not then attain their present height. The uplift of the Himalayas has been responsible for the formation of terraces and deep valleys cut through the conglomerate by the several water courses which now form definite rivers. During the monsoon, these rivers are raging torrents but with the cessation of the rain at the beginning of the cold weather they dry up making it impossible for the workmen to depend on the water supply.

The southern and lower portion of the plateau forms what is known as the Tarai region. Here the water of the rivers that has disappeared up in the Bhabar tract, issues out again and flows continuously and ultimately the rivers fall into the Brahmaputra. Rain falls mostly between June and October, but occasional showers during April and May and also in November and December are not uncommon. The total rainfall average of the year is 165 inches in Kochugaon, a station in the Tarai, but up in the north in the Bhabar tract, the rainfall is decidedly higher. Although the Tarai has an evil reputation for malaria all along the foot of the Himalayas, Kochugaon, the main centre of our activity, has now become the most notorious in India for the highest incidence of a very bad type of malaria. There is a Public Health Laboratory now at Kochugaon where different kinds of malaria parasites and carrier mosquitoes are studied. The chief carrier of malaria here is *Anopheles minimus.* The climate is humid and extremes of temperature are unknown, the maximum and the minimum being 88° F. and 59° F. respectively. Frost is rare.

The forests of Goalpara extending over an area of 905 square miles are as interesting as they are varied. All types of forest from pure savannah to evergreen are found. *Phragmites karka*, *Alpinia allughus*, *Anthistiria* and *Saccharum* spp. represent the low savannahs interspersed with a few tree species, *e.g.*, *Vitex glabrata*, *Eugenia operculata* and *Bischofia javanica*. In the dry savannahs, *Andropogon nardus*, *Imperata arundinacea* and some *Saccharum* and *Anthistiria* spp. are the chief grasses amongst which *Careya arborea*, *Bombax malabaricum*, *Sterculia villosa*, *Dillenia pentagyna* and *Bridelia retusa* are the typical tree species. On the dry savannahs, *sal* trees (*Shorea robusta*) are found in scattered condition. Due to prolonged fire protection some of the *sal* seedlings that grew up naturally in the grass and got burnt annually have now come up and produced fine sapling and pole crop all over the forest where conditions have been favourable. The dry savannahs pass almost imperceptibly into dry deciduous forest in which *sal* forms the principal species and in many localities constitutes 90 per cent. of the crop. The usual deciduous associates of *sal* are *Terminalia belerica*, *Lagerstroemia parviflora*, *Sterculia villosa*, *Stereospermum chelonoides*, etc. In the upper Bhabar where water has not been found by borings even up to 80 feet growth of *sal* is most magnificent and comes up to quality I. Trees have been measured up to a length of 136 feet in Bamba block. In the Tarai where water level is hardly 3 to 4 feet below ground during the rains, *sal* grows and reproduces apparently without much discomfort. It is interesting to see *sain* (*Terminalia tomentosa*) rubbing shoulders with *sal* in clayey localities, and in the damp and the wet localities *Michelia* spp., *Machilus* spp., *Phœbe* spp., *Artocarpus chaplasha* are often the associates of *sal*. In the sandy flats and banks of the rivers *sal* grows side by side with *khair* (*Acacia catechu*) and *sissu* (*Dalbergia sissoo*). In the evergreen forest *Mesua ferrea*, *Michelia* spp., *Cinnamomum cecidodaphne*, *Eugenia* spp., *Phœbe* spp., *Artocarpus chaplasha*, *Lophopetalum fimbriatum*, *Polyalthia cinarium* are the usual species. *Anthocephalus cadamba*, *Trewia nudiflora*, *Bischofia javanica* and *Lagestrœmia flos-reginæ* represent the moist localities.

The first Working Plan was introduced in 1893-94, by which selection fellings of *sal* with a 5 feet minimum girth limit were adopted up to 1902-03. The next plan was drawn up by Mr. Perreé and was brought into operation in 1906 for 15 years. It prescribed Improvement Fellings for all *sal* forests, but the mixed deciduous (miscellaneous), evergreen and *sissu* and *khair* forests remained practically untouched. Between the year 1921 and 1929 before the existing Plan was drawn up, the forests were worked under a so-called *working scheme* which prescribed the year's fellings. The scheme seems to have been disregarded in later years, with the inevitable result that most large sized good trees in accessible localities have fallen under the axe. A new Working Plan has been introduced since 1929-30 for 10 years prescribing among other things, fellings in one part of the forest under the conversion-to-uniform system and also clear-felling and planting in another part.

It is fairly well-known that the existing *sal* forests of Kamrup and Goalpara sprung out of the grass land containing *sal* regeneration burnt year after year. When the reserves were first constituted in 1875, fire protection was rigidly applied and continued till 1916, when it was abandoned. *Sal* seedlings in the grass were thus burnt year after year, but fire protection gave them a great impetus and most of the pole crop of to-day is the outcome.

Although no attempt was made since 1916 to burn the *sal* forests of this division, they caught fire and got burnt here and there, specially in the grassy areas. Young regeneration that was thus burnt every year have now formed beautiful pole and sapling thickets round mother trees in many parts of the division, as a result of fire protection.

The all-important question of natural regeneration of *sal* has now been taken up in right earnest under the new plan. Many observation plots have also been laid out all over the division to study it. The result so far attained shows that introduction of thatch grass (*Imperata arundinacea*) is not probably a necessary preliminary for the germination and first growth of *sal*.

No systematic planting programme was taken up till the new Working Plan came into force. The oldest plantations were started

in 1926, but the area was small. Now 550 acres of plantation are formed annually and also about 12,000 acres of marking and 21,000 acres of climber cutting are carried out.

Sal is the only marketable timber of the division and there is hardly any sale of other hard wood species. *Khair* trees (*Acacia catechu*) as much as 60 feet high and 4 feet in girth are rotting in the forest owing to lack of demand, although in our adjoining province of Bengal and in the United Provinces, *khair* has a ready sale. Of the soft woods, *simul* (*Bombax malabaricum*) is in good demand as the Assam Match Co., Ltd., situated in the district consumes a large quantity of the wood. *Trewia nudiflora* has also been tried for match making, but is not looked upon with favour as the splints warp badly after drying. Lately the demand for some of the evergreen species seems to be increasing.

The division is well-supplied with roads in those parts where forest work goes on, but there are vast areas of evergreens where no exploitation takes place owing to paucity of demand and have not therefore been opened out. The total mileage of cart roads of all kinds is about 200 miles.

The most important mode of transport of timber from the waterless tracts mentioned before is by the Forest Tramway which was laid out as early as 1901-02, with a length of 2½ miles to connect Kochugaon, the main depot, with a floatable river. As the work increased, it was found necessary to supply workmen camping in the dry region with water and the tramway line was extended into the forest to extract the timber as well as to keep workmen supplied with water. To-day the total mileage of tramway is about 43 miles, a main line runs roughly north and south and sidings are laid out east or west according to necessity for extraction and water supply. The gauge is 2 feet and there are 3 locos in all. Last year the Tramway carried 1,100,349 cubic feet of timber to Fakiragram, our nearest station on the Eastern Bengal Railway.

The forests are rich in wild animals of all kinds. Elephants, sambhar, hog deer, barking deer and tiger are found in plenty. Rhino, buffalo, bison, spotted deer and leopards are occasionally met with,

Pea fowl, jungle fowl, black and grey partridges and green pigeons are numerous ; floricans, snipe and quail are found during the cold weather.

The division attracts many people for fishing. The main rivers, *viz.*, the Sankosh, the Champamati, the Aie and the Manas abound in fish chiefly mahseer.

Of the pests that do some damage to *sal*, pig and rats and to some extent monkeys share the blame of killing *sal* seedlings in the plantations. Elephants also pull out many promising young *sal* saplings to eat the roots. Longicorn and Dihammus are most important insect pests, but occasionally, as in last year, whole of the *sal* forest of the Kochugaon sub-division and Guma was badly defoliated by caterpillars but such occasions are rare. Of the fungi, Polyporus is the most important one and is responsible for the death of many *sal* trees.

The entomologist need not feel disappointed at the above description, for he can collect many hundreds of insects of all kinds in these forests.

ON MELOCANNA HUMILIS KURZ

ON MELOCANNA HUMILIS KURZ.

By C. E. Parkinson, Forest Botanist, F.R.I., Dehra Dun.

The Burmese bamboo *Melocanna humilis* was discovered by Sulpiz Kurz in January 1871 near the village of Wanet in the Paunglin (Pazundaung) valley of the Pegu Yomas some thirty miles north of Rangoon. In his Preliminary Pegu Report (1875) Kurz wrote regarding it as follows :—" Just opposite to the village (of Wanet) is a fine patch of a small bamboo very similar to the Arracan berry-bearing bamboo, but the villagers informed me that it only produces a very small fruit. They call it tabeendein, but it is different from the homonymous one in Tenasserim."

Kurz's Wanet specimens of this bamboo in the Calcutta herbarium show only the leaves and culm sheaths which he described; the flowers and fruits were unknown to him. His authority for stating that this bamboo is " common in the Upper mixed forests of Arracan " is not known to the writer.

When Gamble wrote his monograph on the Bambuseae of British India in 1896 he was unable to add anything to Kurz's description and he wrote of the bamboo as follows: "Very little is known of this species; but from the specimens of leaves and sheaths collected by Kurz it would seem to be a *Melocanna*. * * * * It ought not to be difficult to rediscover." It remained unknown, however, from Kurz's time for more than half a century, till December 1928, when the writer rediscovered it growing in a patch about two miles east of Pyinmadaw village and about ten miles east of Wanetchaung railway station. From the locality given by Kurz it seems that this is the identical patch that he saw. It was shown to the writer by local villagers as a result of an enquiry regarding a small *tabindaing* bamboo said to occur there. A photograph * of the bamboo was taken and specimens collected but unfortunately, as in Kurz's case, no flower or fruit was seen.

The bamboo has a typical *Melocanna* sheath and, although the flowers are unknown, the writer is of the opinion that it has been rightly placed in that genus. On account of its small size, compared with the larger, more common, *Melocanna bambusoides* of Arakan and Chittagong, Kurz gave the bamboo the specific name *humilis* but the binomial *Melocanna humilis* had already been used by Roepert in Trinius Clav. Agrost. (1822) 105 and Merrill, in his Interpretations of Rumphius's Herbarium Amboinense (1917), p. 102, has shown that this is merely a new name for *Arundo fax* Lour. Kurz's plant cannot reasonably be associated with either *Arundo fax* Lour. or *Melocanna humilis* Roep. and the latter combination is therefore not valid for the Burmese plant which requires a new specific name. The writer proposes for it the name *arundina* referring to the reed-like nature of the bamboo.

MELOCANNA ARUNDINA C. E. Parkinson, nom. nov.

Melocanna humilis Kurz in Prelim. For. Rep. of Pegu (1875) App. A. No. 1054 and App. B. p. 94 and in For. Fl. Brit. Bur. 2 (1877) 569; Gamble in Bamb. Brit. Ind. (1896), p. 120, t. 106 and in Hook.

* Negative in the Photographic collection at the Forest Research Institute, Dehra Dun.

f. Fl. Brit. Ind. 7 (1897), p. 418; Brandis, Ind. Trees (1906) 683; Camus, Les Bambusees (1913) 180; non Roep.

Herbarium specimens seen :—

S. Kurz No. 3177, Wanet, 3, Jan. 1871 (in Herb. Calcutta.)

C. E. Parkinson No. 1773, Pyinmadaw forests east of Wanetchaung railway station, 10 Dec. 1928.

Tabindaing or *tabeendein* is a name given by the Burmese to a few species of bamboo that produce culms singly and not in clumps or tufts. Brandis was apparently under the impression that this character was more or less peculiar to the genus *Melocanna* and therefore ascribed to it some imperfectly known bamboos with this habit. The homonymous *tabeendein* bamboo of Tenasserim referred to by Kurz and some bamboos of this name given by Brandis in Indian Trees, p. 683, under *Melocanna*, and retained by Blatter under *species dubiæ* in that genus, in *Indian Forester* (1929), p. 608, are more likely species of *Bambusa* than *Melocanna*.

The writer wishes to record his grateful thanks to Mr. C. E. C. Fischer of the Kew Herbarium for his valuable opinion regarding the nomenclature of this bamboo, sent through the courtesy of the Director of the Royal Botanic Gardens, Kew.

NOTE ON CUTWORMS DAMAGING DEODAR SEEDLINGS.

BY J. C. M. GARDNER, I.F.S.

The branch of Forest Entomology has received several reports of serious cutworm damage to *deodar* seedlings in the Punjab and United Provinces in recent years. For example, in 1927 the D. F. O., Kulu, reported that two or three nurseries and 40 acres of patch sowings, showing strong germination, were wiped out, and in 1931 the Conservator of Forests, Western Circle, U.P., wrote that in 1930 and 1931 over 112,000 young *deodar* seedlings had died in the nurseries of Bawar and Riknar ranges in the Chakrata division alone.

This note is based on visits in 1933 and 1934 to the Chakrata division, U.P., where particular attention was given to large nurseries at Mundali. It was not possible to establish a field-station for continuous observation throughout the year with the result that there are large gaps in our knowledge of the life-histories of the insects concerned. However the evidence available is sufficient to indicate simple control measures.

There is no doubt that some forest officers in their reports have used the term "cutworm" too generally. At Mundali there are three chief types of mortality :—

(*a*) Young seedlings, soon after germination, are severed at ground-level. This is typical cutworm damage.

(*b*) Young seedlings and standing transplants, with foliage green, yellow or brown, have the roots severed or damaged below ground-level. This is typical damage by cockchafer grubs, and is discussed in an article by Beeson. [Will appear in June 1935—ED.]

(*c*) Transplants as in (*b*) but with stem and roots intact but dead. Almost certainly due to faulty transplanting. Common in 1933 but not noticed in 1934 to any exent.

The term cutworm should be used for the caterpillars of certain species of Noctuidæ which have the habit of severing stems at ground-level. So far adults of three species of the sub-family *Agrotinæ* have been reared from larvæ taken in *deodar* seedling beds but the cosmopolitan *Agrotis ypsilon*, usually considered as the culprit, has not yet been reared. Several allied species are probably involved, but for practical purposes it will be sufficient to lump them as "cut-worms." The cutworms concerned are smooth dull-coloured cater-pillars burrowing into the soil into which they may drag the foliage they have severed at ground-level. They have a wide range of food-plants and are probably almost omnivorous ; on the other hand, there appears to be no evidence in this or in other countries of any particular interest in coniferous seedlings. The rows of cut *deodar* seedlings found in infested beds suggest by their apparently intact foliage that the plant is unpalatable and that the hungry larva is searching for a more normal food-plant.

The normal food of cutworms in *deodar* forests is grass and weeds. Disused nursery beds in which weeds are growing are very suitable sites from the insect's point of view. If such a bed, or a new one, is weeded and prepared for sowing late in the year many at least of the half grown cutworm larvæ present will be deep in the soil where they will remain in the cold months. As the temperature increases in the early months of the following year, the half grown larvæ come out of hibernation to complete their feeding, only to find *deodar* seedlings instead of the weeds which formed their original diet. In short, any feeding upon *deodar* seedlings is forced and not preferential.

It is reasonably certain then that cutworm damage can be prevented by keeping the nursery site, and particularly the nursery beds which are to be sown, free from weeds from the time when the female moth is ovipositing. This time is not definitely known ; moths from the hibernating larvæ emerge in May but there are probably at least two generations in the year. At Mundali, where seed is sown late in the year, complete weeding from the end of August should be sufficient to ensure the absence of cutworms during the period of germination.

In support of this recommendation it has been noticed that new seedbeds, weeded just before sowing, are heavily attacked and that sites which have been clear of weeds for long periods (*e.g.*, those previously occupied by transplants) are at most slightly attacked.

As a matter of interest it may be noted that cutworm damage to agricultural crops in the U. S. A. and elsewhere is controlled by taking advantage of the fact that the caterpillars are strongly attracted by sweetened bran ; a judicious admixture of arsenic is made. This method was tried on a small scale in the Mundali nurseries showing slightly beneficial results when the poisoned beds were compared with control beds.

HOPLOCERAMBYX SPINICORNIS IN THE SAL FORESTS OF TERAI, KURSEONG DIVISION, BENGAL.

By Y. S. Ahmad, I.F.S.

A great deal has been written during recent years about *Hoplocerambyx spinicornis* in the *Sal* Forests of the Central and the United

Provinces—Bengal has also suffered extensive damage between the years 1931 and 1934, amounting to about two lacs cubic feet of timber, therefore it would be useful to keep record of what has been done to control this pest in this Presidency.

On the 10th May, 1931, a severe cyclone swept over the *sal* forests in the Eastern Terai, in Sevoke Range in Kurseong Division, and damaged five lacs cubic feet of timber. Some trees were blown down, others had their branches and tops broken, and the apparently undamaged trees had their root system badly shaken. As no funds were available the damaged trees could not be felled, logged and extracted. The result was that in the following year this area was attacked by *Hoplocerambyx spinicornis* in abundance ; this insect exists in an endemic form in these *sal* forests.

This attack was first detected in December, 1932, about a year and a half after the cyclone. It appeared that many of the standing trees and the ground surrounding them were covered with wood dust and these trees had shed their leaves untimely. Then on the 30th December two of these *sal* trees were felled and it was discovered that a number of larvæ of about 2 inches to 3 inches in length had completely eaten up the cambium and were making tunnels all round the stem, and some of them had also started boring towards the heart-wood. After this, trees showing similar signs of damage were felled and barked as soon as was possible. In all, about 1850 acres of forest was affected and the number of trees felled was 1,277. In March, 1933, this place was inspected by me, and I noticed that a very large quantity of debris, *sal* tops and branches riddled with insects were lying about in this area. So as an experiment to kill the insects I issued orders that this part should be burnt down with a ground fire. This was carried out satisfactorily on the 10th of April, and the result was that a large number of pupae were destroyed, except those which had already entered the heart-wood.

In addition to the above and in accordance with the measures taken in the Central Provinces to cope with this pest, I ordered that, as soon as these insects were flying about, trap trees were to be felled

at a range of about four hundred feet from each other. Forty-seven *sal* trees were felled for this purpose, between the 19th May, 1933, and the 13th July, 1933. Further, a man was employed for every two trees, to kill the insects with a branch as they came and settled down on the cut surface, cracks or crevices of the trees or wheresoever fresh sap could be found. As these insects came to the felled trees for 7 to 10 days, the trees had to be cut in succession and not simultaneously. In this way about 14,000 insects were trapped and killed. The total costs of felling and destroying the *sal* borers amounted to Rs. 49 only. A large number of beetles were examined and the greatest number of eggs found in one was 306, the average amounted to 250. The mature egg was white and resembled table rice both in shape and length. It was further noticed that the eggs were laid singly and hatched within a week. The larvæ lived in the cambium layer for two or three months before they grew to a length of 3 to 4 inches, and started boring into the sap and heart-wood. Therefore to save the timber from being riddled with holes it is best to start felling and barking them before the end of August.

Later some of the standing trees which were formerly covered with *sal* "damar" or resin were still found to be attacked by these borers at their crowns. In December, 1933, another 1,900 trees had to be marked and felled in the same area. These were mostly above four feet in girth, indicating that *Hoplocerambyx spinicornis* has a tendency to attack the biggest and healthiest trees in the forests. Further as a point of interest it would be well to add that these pests not only attack *sal* trees of the plains, but they also appear on high elevation—for in the rains of 1933, the writer noticed them flying about at Latpanchar, an elevation well above 3,000 feet.

On the 3rd April, 1934, this forest was again burnt by ground fire but the fire was not very intense as there was less debris on the ground. Thirty-seven trap trees were again felled in various parts of the area; and between May and July, 1934, about 11,600 insects were killed at a cost of Rs. 23-12-0 only. This year the actual process of trapping was different from the previous one in this respect that the beetles were killed from the cut surface of a tree for three or four days

only, and thereafter gashes were made on the bark at intervals of 5 to 6 feet all along the felled tree to attract the insects. These borers were collected the next day from under the bark and destroyed. If any eggs were found these also were carefully removed and destroyed. By this process beetles could be trapped for a period of 20 to 25 days on each tree as against the 7 to 10 days of the previous method, thereby reducing the expenditure and unnecessary waste of trees. As a result of these operations the damage from this pest has been brought under complete control. I should further like to mention that the *sal* trees felled before the 15th of March in these forests dry up to such an extent that no borers can attack them during the following rains, and trees felled after that date should be completely barked, and their tops and branches disposed off in order to prevent the attack from *Hoplocerambyx spinicornis*.

In conclusion I suggest the following measures as a prevention against this pest :—

I.—In areas swept over by cyclone all damaged trees should be felled, barked and logged without delay, the tops, branches and debris should be disposed off immediately.

II.—At the first signs of the onslaught of this insect—

(*a*) The affected forest should be burnt with a ground fire before the rains set in.

(*b*) Trap trees should be felled, and after the first three or four days gashes should be made all along the bark to attract the insects, so that they may be collected and destroyed.

NOTES ON MR. Y. S. AHMAD'S PAPER.

BY FOREST ENTOMOLOGIST, F.R.I.

A.—When *H. spinicornis* is abundant its attack is not selective, but is distributed uniformly throughout the growing stock. If the observed mortality in the higher girth-classes is greater than the average ratio, it indicates that the killed trees of high girth are relatively less resistant, not that they are more liable to attack. The biggest trees are not necessarily the healthiest.

B.—It is premature to claim that the pest has been brought under complete control since no figures are given for the 1934 mortality, and the 1933 mortality was greater than that of 1932.

C.—A ground-fire in the hot weather is of no value as a means of destroying *Hoplocerambyx* in logs and big branchwood and there is no point in destroying small branchwood and refuse in which the borer does not breed. A fire fierce enough to kill pupae in heart-wood will damage standing trees. Ground-firing is, therefore, not recommended as a standard remedial measure.—(*C. F. C. Beeson*).

FORM FACTORS FOR KOSH (ALDER) FIREWOOD.

By Naranjan Singh, P.F.S.

In March 1934 an experiment was started at Bhuin firewood depot to determine the shrinkage which takes place in *kosh* firewood, and the results are as below :—

One stack 100 cubic feet ($5' \times 5' \times 4'$) of split firewood and one stack (100 cubic feet) of branch firewood were weighed on 13th March, 1934, they were again weighed on 25th June, 1934, and on 15th September, 1934, and finally on 15th December, 1934. When weighed for the first time on 13th March, 1934, the firewood was absolutely fresh from the stump.

The details of the weighings were :—

	Split wood stack 100 c.ft. $5' \times 5' \times 4'$		Branch wood stack 100 c.ft. $5' \times 5' \times 4'$	
	Mds.	Srs.	Mds.	Srs.
When fresh on 13-3-34	27	0	13	20
15-6-34	18	0	8	20
15-9-34	17	0	8	15
15-12-34	16	10	8	15
	Per cent.		Per cent.	
Reduction percentage being ..	39		38	
Final utilizable weight being ..	61		62 per cent. of original weight.	

The final results of the total firewood cut for the year 1934 (222 maunds

20 seers split wood, 48 maunds 2 seers branch wood) also confirmed the above conclusion. These percentages of utilizable firewood after making allowance for shrinkage may therefore be taken as quite reasonable for working out the ultimate utilizable weight of this wood from the original fresh weights.

2. From the weighment of a few stacks I determined also that the weight of 100 cubic feet volume was more or less constant, *i.e.*, in the vicinity of 27 maunds in the case of split wood, and that branch wood was almost half the weight of split wood. Thus as a sort of reasonable form factor for *kosh* firewood for determining weight from volume we may say that :—

(*a*) *In the case of splitwood*—

Volume in cubic feet $= \frac{100}{27}$ of weight in maunds or weight in maunds $= \frac{27}{100}$ or ·27 of volume in cubic feet.

(*b*) *In the case of branch wood.*—

Volume in cubic feet $= \frac{200}{27}$ of weight in maunds or weight in maunds $= \frac{27}{200}$ or ·135 of volume in cubic feet.

REVIEWS.

A KEY TO THE EUCALYPTS, WITH DESCRIPTIONS OF 500 SPECIES AND 138 VARIETIES, AND A COMPANION TO J. H. MAIDEN'S CRITICAL REVISION OF THE GENUS EUCALYPTUS.

By W. F. Blakely, Price 10 Shillings.

The Eucalypts, among which may be numbered some of the world's most elegant, useful and widely-planted trees, belong to a genus said to be one of the most protean in the plant kingdom. "Every character, irrespective of size, is subject to change. There are variations in the cotyledons, juvenile, intermediate and mature leaves, buds, anthers, fruits, seeds, bark, timbers, oil and kino." This protean nature, coupled with the fact that it has hitherto not been possible to obtain short descriptions of the 500 species that the genus contains, has made the identification of the Eucalypts a matter of considerable difficulty and uncertainty even for the experienced systematic botanist. The appearance of this comprehensive handbook is therefore welcome. It contains, as its title denotes, a key to the species based chiefly on the characters of the anthers supplemented by other characters of the flowers, leaves, bark, etc. These anther characters are well explained by means of clear diagrams. The book, however, does not give only a key ; useful uniform descriptions are given for each species with notes on their ecology, utility, ornamental value, occurrence and flowering times as well as lists of the species

alphabetically arranged according to the common and botanical names, with synonyms, of the principal works on the Eucalypts, of fossil species attributed to the genus and of the species yiedling the best timbers. It is dedicated to the memory of the late Mr. J. H. Maiden with whom the author was associated in connection with his great work, the Critical Revision of the genus Eucalyptus, to which it is also meant to be a companion. It should prove useful to botanists, foresters, horticulturists and all lovers of trees.

C. E. P.

FOREST ADMINISTRATION IN THE NORTH WEST FRONTIER PROVINCE FOR THE YEAR ENDING 31ST MARCH 1934.

There was no change in the area of reserved and protected forests under the control of the Forest Department. As the Wali of Swat was again unable to find a purchaser for the outturn from his forests, no fellings were made—thus three years prescriptions have fallen in arrears. Swat timber has a bad reputation for splitting when used as railway sleepers. Possibly, if treated with earth oil and creosote, this splitting might be stopped.

Voles continued to be a menace, especially in parts of the Galis division—they have been kept out of nurseries by wiring them with mesh netting, and the use of the cynogas pump, but this method is impracticable and too expensive to employ over large areas.

Natural regeneration in *chir* forests is reported as being mainly excellent, but that in the blue pine forests it is slow. It is however encouraging to learn that at long last blue pine regeneration is appearing in the felled areas in the Galis division, doubtless due to the improved condition of the soil. The artificial regeneration of blue pine in these areas has given excellent results, and the staff concerned are to be congratulated on their success, especially after so many years of failure.

The Conservator has some very interesting remarks to make in the Chapter on Research and Experiments, regarding the condition of the soil for obtaining blue pine regeneration. There is little doubt

that a close study of the soil and its horizons goes a long way towards solving the problems of regeneration of many species.

It is interesting to note the remarks on the Trout fishing and the hatchery in the Kagan Valley. But surely 9,500 Ova obtained from the stock fish is a very poor figure, unless the fish are in a poor condition. It is usual to estimate that a mature hen fish will give 1,000 Ova for every pound of weight. Apparently the fishermen of the Kunhar river differ from their brethren in the rest of the world, in that they do not talk of their prowess, nor have they apparently lost their sense of proportion !

The surplus on the year's working shows a big decrease. Rs. 36,950/- against Rs. 1,20,912/- last year. This was due to several factors, the chief being that in the previous year, standing trees were sold in addition to a large stock of sawn timber on hand from previous years, while very little sawn timber was sold in the year under report, on account of the stoppage of departmental exploitation.

A very interesting report which shows that forestry is very much alive in the North-West Frontier Province.

G. R. H.-G.

THE JAMMU AND KASHMIR FOREST ADMINISTRATION REPORT FOR THE FASLI YEAR 1889-90 (ENDING 16TH OCTOBER 1933).

The Jammu and Kashmir Report records steady progress in the management of a valuable Forest Estate.

This Report records a net surplus of Rs. 25,84,457 representing 68 per cent. of the receipts which is very creditable to the State Forest Officers and we congratulate Sir Peter Clutterbuck on the result.

An interesting feature of the report is a comparison of revenue produced by each division. Sindh division standing first amongst the revenue-producing divisions. This should give an incentive to the Divisional Forest Officers to economise and tap all sources of revenue in their charge.

The Kashmir State is making an appreciable revenue from minor forest products such as *kuth* (*Saussurea lappa*)• resin, and *Artemisia*.

About the end of December 1932 due to a restriction of output and a rise in grain prices there was an upward trend in the timber market, prices having risen 40 per cent. above the summer level. The expectations of the middlemen however were not realised as the public would not buy at inflated rates. The result was intensified depression in the trade and prices fell heavily in the early part of 1933. The restriction in the output however did not have an immediate appreciable effect as large balances that had remained in the forests were still being brought down to the markets. The depression was further intensified by heavy rejections of sleepers by the North Western Railway with consequent flooding of the market with rejections and a consequent drop in prices.

The report takes note of the continued use of wood substitutes, in particular cement and reinforced concrete beams, now increasingly used in the towns, thereby restricting the timber market mostly to village communities only.

As a result of the depression in trade the forests were worked at about half of their normal capacity. This is not so bad. but the suspension of thinning operations all over the State except in 2 or 3 divisions is very unfortunate.

Both as a result of a dry autumn and political agitation in the State there were cases of incendiarism and the services of some members of the Gazetted Staff were requisitioned by the District Magistrate to work as Special Magistrates in addition to their own duties.

No amount of legislation or fixing communal responsibility will stop incendiarism where fires are an indication of the protests of the public against the isolated and arbitrary actions of forest subordinates. It is for the territorial officers to see how far this incendiarism is the result of genuine grievances and to remove any real cause of complaint.

The report records losses of regeneration in *chir* forest as a result of incendiarism and fires. This is very sad, but it has been conclusively proved in the Punjab forests that *chir* regeneration areas can be protected against the severest summer fires if the forests are kept clean of all refuse and seedlings and saplings are sufficiently thinned

and a fire run through the area during the winter. This requires intensive operations, but they are inexpensive and the surest method of insuring against repeated calamities.

Forest nurseries are being very systematically organised and the report records 15 lakhs of *deodar* seedlings transplanted into the forests during the year.

The Kashmir Forests are faced with the same difficulty as the Punjab in so far as they are finding it difficult to regenerate the forests within the period allotted. It is increasingly felt that some sort of preparatory felling should be started in P. B. 2 so that no time is lost in completing the regeneration in the areas placed in P. B. 1.

The Chief Conservator of Forests rightly sounds a note of warning about the position of Working Plans. The territorial staff is unable to cope with this extra work thrown on them which is the proper concern of a well-organised Working Plan Circle which still remains in abeyance.

The Game Preservation Department was amalgamated with the Forest Department in 1899 (*Fasli* year) and the Divisional Forest Officers were invested with powers of 3rd Class Magistrates to try cases under the Game Laws.

A. B.

EXIRACTS

THE THANA FORESTS (REVISED) WORKING PLAN.

The plan is a revision of the 1922 Working Plan, based on the notes made by the Divisional Forest Officer, Working Plans, during the period 1928-31, with several entirely new chapters dealing (*inter alia*) with the systematic organization and exploitation of newly constituted working circles Nos. (*iii*) to (*x*), which in the past had either been overlooked or inadequately dealt with.

Part I contains Past History brought up-to-date to 1933.

Part II contains the following chapters:—

Basis of Proposals.—General objects of management, formation of working circles, notes on felling series, period of the plan and necessity for intermediate revision.

The Main (Timber) Working Circle comprises the greater part of the forests. The method of treatment adopted in the Working Flan of 1922 is to be continued, *viz.*, that of clear felling with natural regeneration from coppice and seed supplemented by extensive artificial regeneration during the two years following exploitation:—

The previously fixed rotation of 30 years has been retained and the yield is controlled by area.

A scheme of thinnings has been drawn up for the old coppice with standard coupes under which apart from regular thinnings, the old standards will be removed during the period 1933-34 to 1943-44.

As regards the coupes clear-cut under the Working Plan of 1922 four thinnings have been prescribed as follows:—

I	thinning	in	the	11th	year
II	,,	,,	,,	26th	,,
III	,,	,,	,,	46th	,,
IV	,,	,,	,,	66th	,,

The Pole Working Circle comprises the poorer forests which are to be worked on a short rotation for the production of poles and firewood.

The method of treatment is the same as that laid down for the main (timber) working circle, the only difference being in the length of the rotation, which is fixed at 40 years, and the frequency of thinnings, only two ordinary thinnings being fixed instead of four and none in the old coppice with standard coupes.

The Talasari Working Circle comprises areas which have to be worked through quickly as the stock is deteriorating. The present prescriptions for this Circle are the same as those for the pole working circle but the ultimate idea is to include it in the main working circle.

Newly Afforested Areas Working Circle is constituted of areas which will eventually be included in other working circles when sufficient data have been collected.

Casuarina Working Circle.—The prescriptions for this circle are clear felling with complete artificial planting with an espacement of $9' \times 9'$ on a 20-year rotation. The yield is regulated by area and thinnings are to be made in the 7th and 14th year.

Kuran Working Circle.—This circle comprises grass producing areas. Each kuran will be sold annually in August for cutting only, but it will be opened for cattle grazing in the months of April and May in each year.

Babul Working Circle.—This comprises an area of 213 acres along the south-west side of the Manori creek. The rotation is fixed at 36 years and one coupe will be clear-felled every alternate year and regenerated by sowing babul seed, which has been previously ingested by goats and sheep on ploughed lines 6′ × 8′ apart. Cleaning is to be done annually upto the 5th year and two thinnings are prescribed, *viz.* at the 10th and 20th year.

The yield will be controlled by area only.

The Inexploitable Working Circle.—Fellings will not ordinarily be made in this circle, but certain of these areas from which material can be profitably exploited may be worked under sanction of the Conservator by the territorial Divisional Forest Officers on the selection system.

Matchwood Working Circle.—This is an overlapping working circle. The match-wood coupes will be worked under the selection system on a 20-year felling cycle and only trees suitable for matchwood and over 30″ girth will be exploited.

Bamboo Working Circle.—This is an overlapping working circle. Bamboos will be worked under a three-year felling cycle. No shoots of the preceding monsoon will be cut, and one-third of the green bamboos of each clump will be reserved.

Miscellaneous Regulations.—This chapter deals with roads and buildings in forest cultivations, maintenance of boundaries, survey and maintenance of maps.

Staff and labour.—This chapter deals with the necessity of creating an additional division and of augmenting the cadre of rangers, foresters, guards and clerks to cope with the additional work entailed by the prescriptions of the Revised Working Plan.

Financial forecast.—The annual net revenue for some years at least is estimated at Rs. 12,50,000 which with the improvement in the timber market is likely to rise in future.

USE OF MODERN MACHINERY WILL HELP TO ARREST WOOD SUBSTITUTION

By "Wogan."

The minutes during which a machine is working and the quantity of work that it will do in a minute is such an important factor that it must be brought home with all possible emphasis.

The problem is not only an academic one, or even a matter of profit and loss ; it is one of survival. I am, however, no scaremonger. Evolution comes so nicely that the next generation will be able to adapt itself to changing circumstances, but in the process of the change some are bound to get hurt ; and while it cannot be said that it is their own fault, it can at least be said that many commercially do not seem to mind dying without a kick.

At present it costs too much to fell wood, to transport it and to work it. Regarding many of these things it may well be that the costs are as low as is possible, but in bulk, when the enormous loss that takes place in wood conversion—some of it

unavoidable and some avoidable—is included, then scarcely anyone will deny that something must be done if the uses of wood are to be retained.

I am a lover of wood. Perhaps this is a matter of circumstances inasmuch as I earn my living indirectly by wood ; yet I know of nothing so charming as a nice piece of woodwork properly finished. Somehow it hurts me to see a substitute, not that I object to the fact that it is a substitute—but it does not appeal to me—there is something unnatural about it.

Exploring Every Avenue.

Some people seem to believe that wood is disappearing, not because we have found something altogether better, but because we have found something sometimes more convenient and sometimes cheaper. Of course, you do not believe it, but think a minute! Big vessels and liners are now built of steel ; no longer is wood used. "Ah!" you say, "but rowing boats and motor boats are still of wood." Nonsense, they are now being made out of steel stampings—at less cost.

"What a feel there is about that new driver of yours—a good bit of hickory"

"But look at that fellow over there ; all his clubs have steel shafts!"

Anyway, the heads are persimmon, but for how long? There are several things from which golf driver heads can be made—aluminium or hollow steel shells are welded, for instance. So through the whole gamut of utilities and styles this insidious encroachment goes on. One can buy picture mouldings and skirtings now that are not made of wood ; it might soon be possible to obtain a whole moulded roof in jointing sections, or a door, or anything.

All this leads to the fact that, generally, we are not organised as well as we should be. It means (as the politicians say) that every avenue must be explored not only to boost wood—in itself not sufficient—but to make wooden articles comparable in price with substitutes.

Of course, we cannot grow square trees (don't smile, strange things are done every day) and so we are faced with a big percentage of waste ; but when the wood really gets into our place we should see to it that as little waste as possible takes place there, and that we pay as little as possible for its conversion.

What Must Be Done.

To do this we must not only avail ourselves of the best machines, but we must see that they are used with an eye to getting as much out of them as possible. This means spending money, not only on the machine but on the equipment, and this is always a sore point. Is it not a fact that we consider a problem for too long, instead of making up our minds? Of course, one has every sympathy with the fact that so many changes are made in a day, and that jobs vary so much from time to time ; but there are certain well-defined runs that will pay for the most elaborate equipment, even if it does more or less go out of date before it is worn too much.

Take sash wood as an example. This work can be done on a modern machine at anything over a hundred feet per minute. It is a recurring job and therefore it should

be run with solid profile cutters. What is the first cost of six or seven pounds a cutter compared with the extreme simplicity of setting up, the ease of grinding, and the feed speed ?

One knows very well that points are urged against every known method, and it is not right to accept any statement at its face value. There are, however, many mills which, having adopted this modern way, would never think of turning back. A little investigation would convince one of the possibilities at least.

Again, take the case of the Shimer head. No one has anything but respect for the head designed by Samuel J. Shimer, but honesty must compel one to say that the head to which Bolinder gave his name is a more useful tool for high-speed work. Nevertheless, there are thousands of mills in the country to-day which will not turn over to the profile head, and still replace their cutters when they are finished by new ones of the same type.

It must be acknowledged that a vast improvement has taken place in the last decade There is a production spirit about, and centralisation and standardisation have to some extent been gone into, as for example, the factory producing doors or windows exclusively ; but there are still further ways to travel if we are to retain what we have held on to.

The double end tenoner which does ten times the work of the single end machine ; the glue spreader which covers a surface evenly at a rapid rate ; the edging saw that cuts quickly and saves wood, and the fast moulder and planer that knocks minutes off an operation and the preparation for an operation, together with all the other production machines will stave off commercial defeat, for some time at least. Your man who says 350 feet per minute is too fast for pianing flooring regularly does not recognise the fact that others are finding it not fast enough, and is one of those who are driving a nail in the wooden coffin.

I feel like a prophet of calamity, after writing this article. But at least you can have your revenge—see that I am a false one ?

THE PEINT FORESTS AND PEOPLE OF THE WEST NASIK DIVISION.

By H. P. D.

"In Nasik," it is said by local scoffers, "there are more forest officers than trees." And when the gaffaws that generally greet this time-worn jest have died down, we are obliged to admit that there is just the necessary substratum of truth in the assertion to justify the flippancy. For, whatever the attractions of Nasik as a place of pilgrimage, a golfer's paradise, or a refuge from the swelter of Bombay, there is nothing in its immediate surroundings to suggest the presence of extensive forests. Tall timber is not an obtrusive feature of the landscape. None of my readers who may have occasion to pass by Nasik on their way to or from Bombay, would see much from the carriage window at any rate within the boundaries of West Nasik to arouse their professional interest. The activities of the Department are conducted off the stage, well below the immediate skyline.

The observant traveller, however, when he looks out across the wide Deccan plateau, broken by its sudden steep and sometimes flat-topped hills, may perhaps observe a file or two of timber laden carts lurching across country, or drawn up patiently at level crossings ; and if either interested enough to enquire or fortunate enough to find an informant may learn that they have had their origin in the forests of Peint, sixty, eighty or more miles away to the westward.

Peint (the 'n' is pronounced as *anuswar*) is a mahal, or subdivision of Nasik District, distinct from the rest in almost every feature: people, climate, customs, crops and geographical formation. Cupped in the Sahyadris, or Western Ghats, it immediately adjoins the main escarpment of the Deccan plateau, along the base of which it stretches for some forty miles—a rugged strip of broken country, 15 to 20 miles in breadth. This is the real nucleus of the West Nasik Division, and consists in about 450 square miles of forest, covering the steeper slopes and alternating with small belts of cultivation on the spurs and ridges.

The approach to Peint from the Deccan side is sufficiently startling. The eye, lulled to inattention by the shifting samenesses of ridge and plain is taken completely off its guard when a passing fold yawns asunder to reveal a sudden unimagined underworld. A thousand feet below, a blue vista of tilth and treetop stretches indefinitely.

This is a regular feature of the Western Ghats and found almost throughout their whole length. In some places the descent is more gradual, but mostly there is a distinct and almost perpendicular escarpment.

Seen at the end of the rains, the panorama from above ghats is a brilliant patchwork of greens, yellows and browns, the dark masses of the forest contrasting vividly with the bright tones of the ripening crops and the sombre shade of the ploughland. Here and there a shapeless huddle of drab thatch or tile, set among mangoes, and flanked by a patch of plantains, maybe, or a few stray toddy palms, mark the presence of a village. These villages are almost invariably small and isolated, yet so numerous are they that the entire region, although

predominantly forest, supports a population of nearly sixty thousand souls.

The soil, in contrast to the rich black cotton clay of the uplands a few miles to the eastward, is a harsh shallow reddish trap incapable of retaining moisture in the dry weather, and therefore useless for *rabi* cultivation.

Enough subsistence has to be wrung out of the monsoon crops to support the cultivators throughout the year. The tiny holdings have not only to furnish a twelvemonths' nutriment, but, in addition, an actual surplus of marketable grain, to be converted into land assessment, *sahukar's* dues, and such secondary necessities as sugar, salt, oil, dried fish, cloth and blankets. The resulting standard of life is scarcely short of starvation.

Endurance, no doubt, of such conditions through the course of centuries has accustomed the inhabitants to spare living. They have developed great ingenuity in supplementing their diet. They are expert bowmen and indiscriminate *shikaris*. In consequence almost all forms of edible wild life have long since vanished from the forests and the existence of the survivors is extraordinarily precarious. Deer, needless to say, are virtually unknown ; even monkeys are exceedingly rare. The writer has been assured (by would-be gun licensees) that pig exist and do damage to the crops, but in five years' exhaustive wanderings has failed to encounter one. Hares and fowls have not yet been exterminated in the denser jungles, and provide material for an occasional grand battue, when they are beaten into nets and runways.

A large number of the inhabitants are Kolis, who, as the Marathi word implies, are primarily fisherfolk, and they may be seen in the exercise of their profession in the summer months, when whole communities collect around the standing pools in the dry river beds to bale out any " tiddlers " that remain. While the streams are still running earlier in the year they either set cruives or poison the waters with fruits of *Randia dumetorum*.

Typical forest village in Peint.

A Koli *shikari*.

A village musician.

Photos H. P. Davis.

A sub-caste exists, known as Dhor Kolis, whose stomachs must be specially resistant, for they consume all kinds of carrion, including natural deaths among the village cattle, without ill-effects, and even more strangely, without losing their touchability. A three-day old panther kill is esteemed a special delicacy. Even the jungle rats that live in hollow trees are eagerly sought after, and their extrication is responsible for many a case of illicit cutting.

Backward and primitive as they are, these jungle peoples are yet singularly attractive. They are untouched by political virus, and are friendly and loyal to Government. They are fundamentally truthful, honest and moral. Their worst vice is one which they share with more enlightened peoples : evasion of the liquor laws.

They are practically all forest villagers, which entitles them to innumerable privileges, which joined with the wages they earn on forest works, help them in their struggle for existence.

Their ills sit lightly on them. Under-feeding, drought, malaria, asthma, guinea worm, epidemics, the constant rapacity of the *sahukars*, poverty hardly to be paralleled elsewhere : all these have failed to quench their natural gaiety. They seem to enjoy a crowded social life. With all their poverty they possess one boon in common with the rich : the gift of abundant leisure, for their unproductive soil absolves them from toil for at least a part of the year, and they are quite untrammelled by the cares which a higher standard imposes.

Ample time is always at hand for excursions to sacrifice a goat or cock in honour of some tutelary god, for week-ending with their friends in other villages, or even for lengthy treks to distant fairs and *yatras*.

Religious feasts cluster thick on their calendar, and must be observed with all due ceremony. *Shimga* (elsewhere known as *Holi*) is perhaps the most important of these. At that season it is well to be provided with a pocketful of change, for there are parties of mummers to be met with "doing their stuff"—and very salacious stuff it is too—and the lasses of the village, usually so shy, wax bold enough to stretch cords across the road in front of the Sahib's motor and demand toll.

Apart from the seasonal festivals there are occasional rituals no less important. One is the ceremonial expulsion of the small-pox deity, which they consider much more effective than the prophylactic measures of the Board of Health. The main idea of this proceeding is to unload the unwanted goddess on some other village, leaving them to "hold the baby" or play the same trick on their neighbours. The whole community march in procession to the precincts of the nearest village, chanting propitiatory hymns, and deposit there a number of baskets containing tiny flags and clay images of *Devi*.

But undoubtedly their greatest solace is the *mohwa* flower. This tree, *Bassia latifolia*, grows thickly all over Peint and fulfils for its inhabitants the same function as that of vineyards in Europe. In March and April when the blossoms form, one may see the ground beneath each tree swept and garnished, and a lass or lad in possession of the pitch, watching for the flowers as they distend and fall one by one in the midday sun. In theory they are collected for transmission through contractors to the Government Distillery. Actually by far the greater portion find their way to the illicit stills that spring up everywhere during the monsoon. And if we picture the abysmal squalor of a forest village in the rains we shall find it hard to blame the inhabitants for seeking the sole comfort nature so bountifully provides.

Licit or otherwise, the essence of the *mohwa* flower is the basic factor in the sounds of revelry by night so characteristic of this region at all times. The Peinti could outnight the heartiest of London's "Bright Young People." And no one listening with a drowsy ear to the distant throb of tom-tom or the faint cheer and fitful skirl of piping borne upon the breeze would judge himself among a people either discontented or morose.

The system of cultivation practiced in Peint is peculiar, I think, to the Western Ghats. Loppings of trees are burnt to form the seed bed of *nagli* (*Eleusine coracana*) the staple crop. It is incorrect to regard this as simply ash-manure. Recent research has established the fact that the real action of the burning is to kill all protozoa near

the surface of the soil, with the exception of those engaged in the formation of nitrogen, and to allow full rein to the latter elements. In Peint the forests in the immediate vicinity of villages are classified as Protected, and open to the privilege of lopping; only the remoter forests are Reserved. In the Protected or "*rabi*" forests only teak, *tiwas* (*Ougeinia dalbergioides*), *Dalbergia latifolia* and the fruit trees are exempt from lopping, and this arrangement, by ensuring the mutilation of their oppressive neighbours, operates to the advantage of the former. In many of these forests the teak indeed is already in excessive proportion and would be benefited by the re-introduction of some vigorous jungle woods.

The lopped trees, with their little tuft of foliage, retained by regulation on the topmost branch, like a single lock of hair on a tonsured skull, present a quaint and outlandish appearance. When in full leaf in the cold weather they look in the distance like Normandy poplars or sometimes in the soft colouring of evening like cypress avenues on an Italian landscape.

These topiary operations proceed apace in the hot weather, and by the middle of May the neat squares of brushwood may be seen on every upland rise. Then one day, like the exploding dumps of a retreating army, tall white columns of smoke mount on the horizon and gradually in ever increasing numbers spring from every fold of the landscape till their drifting fumes obscure the sun. At night the dark contours near and far are pierced by little glowing lines of light.

When the fires die down the tiny grains of *nagli* are sprinkled on the ashes, which under the action of the monsoon downpour quickens into a livid flush of green. This is the seed-bed; the young corn has yet to be transplanted; but in a region where the rainfall averages a hundred inches, transplantation is a simple matter. The seedlings have merely to be strewn in rows along the ready ploughed furrows. Protected from the pelting showers by their "pangonghris"—a sort of keeled hood made of teak leaves woven on to bamboo frames—the peasants engaged on this task resemble monstrous beetles. The seedlings root themselves, and by the end of the rains the wavy tufted grain is ready for the reaping.

Access to Peint from the direction of Nasik—a distance of 20 to 30 miles—is afforded by three ghat roads, which descend the face of the Deccan cliff into Peint-proper and then follow the line of the river valleys from east to west. A trio of great rivers, possessing the sonorous names of Nar, Par and Damanganga, issue from the slopes of the Sahyadris and rapidly scour the country into a series of precipitous gorges. Towards the western boundary the difference between the level of the ridges thus formed and the river beds approximates sometimes to 1,200 feet, making lateral communication extraordinarily difficult. It is on the lowest slopes of these ravines that the deepest soil occurs and the most valuable teak, the extraction of which is the main problem of the division.

Peint is the Poland of the Bombay forests—but without the Corridor. Shut in on almost three sides by Native States, and cut off from access to the coastal bundars, she is compelled to seek her markets in the Deccan hinterland, where trade is confined to the small towns and distances are immense. Coupes whose price in the more favourably situated Thana divisions, a few miles to the south and west, would be reckoned in thousands or tens of thousands of rupees here fetch only so many hundreds. Their *injaili* contents that the Bombay market would absorb greedily in the form of charcoal from the railhead forests of Thana, are here a useless and harmful element whose removal is an unproductive charge.

Yet the situation is not entirely hopeless. The problem of putting Peint upon the commercial map has exercised the Forest Department for years, and the question of an outlet to the coast has at last reached the stage of practical politics. After heroic efforts the Forest Engineer and his satellites have evolved an "all red route" through a narrow strip of British territory, previously believed impenetrable, from Peint into North Thana Division. The discovery of a possible alignment in such irregular and precipitous terrain is no small achievement. In twenty-eight miles of its course the projected road will not exceed a gradient of one in twenty. Now only Government sanction and the necessary funds are awaited.

Valley of the Damanganga river, Peint, at present inaccessible.

Photo V. G. Kulkarni.

Unfortunately this new route will affect only a portion of the area: the greater part will still remain cut off from its benefits by natural barriers. Failing some catastrophic revolution such as the collapse of the world's timber supplies that has been so often predicted, or some unexpected local development such as an airport or an oil strike in Peint itself—all very unlikely contingencies—there seems little probability of the bulk of Peint forests ever serving any but their present markets.

The poor profits obtaining in the existing markets operate as a limiting factor in the development of internal communications, and this again reacts on the profits, establishing a vicious circle. Access to the areas under exploitation is of course essential, but all elaborate construction has to be avoided. It has been necessary to improvise a system of inexpensive earth-tracks, which avoid rock-cutting as much as possible and try to reach their destinations by circuitous and easy routes. The actual extraction from the coupes themselves, which are generally situated on rocky slopes, to the nearest of these roadways is effected by buffalo haulage along "*jali-margs*" or drag-paths, cut through the forests.

With the exception of the main route from Nasik, which is under P. W. D. control, the whole road system in Peint, part of which is metalled, is maintained by the Forest Department. This amounts to about 120 miles, and is a heavy item on the programme of work, engaging the attention of most of the staff for the first two months of the working season.

Thereafter and for a brief interval only, until the timber laden carts have furrowed and pulverised the surface again to a foot in depth and the dust chokes the carburettor and the driver, it is delightful motoring on the firm forest tracks. The car slips gently through leafy glades; sometimes skirting the edge of a yawning chasm, sometimes winding down by innumerable curves to the bottom of a gorge, over the channel by a fascine bridge, and up the other side. The track often crosses "*malki* numbers" where the women are busy reaping, their heads bound with bright cloths, or the muzzled oxen on the threshing floor are treading out the corn. For a spell we may

plunge through the penumbra of dense high forest, and the next moment emerge abruptly on a sunlit clearing to the cheers of the little village urchins.

From such excursions we may pass to a silvicultural survey of the region. The forest is typical mixed deciduous or monsoon forest. The system in force in the reserved and in modified form in the protected forests is Selection-*cum* Improvement of the main species *viz.*, teak, *khair* (*Acacia catechu*), *shisham* (*Dalbergia latifolia*) and *tiwas* (*Ougeinia dalbergioides*), combined with artificial regeneration on cleared patches. The teak content is very variable ; in some places it forms almost a pure stocking, in others it is non-existent. It is with the idea of remedying the latter condition that clear cutting has been introduced. The state of the teak is generally poor. Even in the best areas the stand is encumbered by superannuated stems gnarled and twisted out of all symmetry, and the mature and middle-aged classes are badly damaged by neglect and injury in early life. Barely half a century has elapsed since these forests first came under departmental control, and scientific tending has been seriously attempted only in very recent years. The silvicultural methods applied here do not differ materially from those practiced elsewhere under this system and need not be discussed in detail.

The extermination of the harmful species, however, presents particular difficulty. Girdling is uncertain, felling expensive. There is little or no demand for charcoal, partly owing to length of lead, and partly to difficulty of making. After the first couple of months of the fair season the streams dry up, and it is impossible to construct kilns except in a few places. Experiments made in this locality with mechanical kilns that need no water have not been a success, and in any case the initial cost of such apparatus on a commercial scale would be prohibitive.

What appears to be required is a very cheap yet certain method of eliminating the undesirable elements. A hypodermic (or should one say hypocortic ?) syringe charged with some cellulose-disintegrating serum would be a useful instrument in a marking officer's hand. I commend the idea to the Forest Chemist for what it is worth !

A typical two years old teak *rab* in Peint in a coupe felled under Improvement System.

A group of cheery little road workers in Peint.

Photos H. P. Davis.

The system of regeneration derives its inspiration from the local methods of cultivation already described. *Rabs* of the uniform size of one or two square chains (to facilitate estimation) are heaped with the débris of the felling, burnt before the rains, then sown or planted with teak, and occasionally *shisham, shirani* or *khair.* Seeds are dibbled in at stakes aligned at six foot intervals, or alternatively, stump plants are used. Blanks are beaten up in the course of the rains from stakes where there are surplus seedlings.

The preparation and piling of the brushwood entails a cost of nearly Rs. 3/- per *rab*, and whether done departmentally or by contractor, reacts unfavourably on the profit of working, since the cost to the contractor comes out of the price he is prepared to pay for the coupe. When other incidentals such as burning, clearing, staking, dibbling, various weedings and cleanings, etc., are added, it becomes more than doubtful if we can expect to be all square with bogey, *i.e.*, 1. Op, at the end of the rotation.

Until recently touring in Peint was an arduous adventure. With the exception of the three main approach roads from Nasik, which penetrated for a short distance only into the interior, there were no motorable tracks and only three or four furnished bungalows. Beyond the limit of a day's excursion from one of these, all cross-country touring had to be conducted by headload, and intermediate halts were made either in small tents or temporary grass *mandavs.*

Such a form of transport was no doubt ideal for mobility and speed, but it precluded touring *en famille*, much of the essential paraphernalia of which cannot be resolved into single coolie loads. It was certainly not conducive to that standard of living which it is now realised is essential in an unhealthy climate.

The climate of Peint is regarded as one of the most malarious in the Presidency, and service there is dreaded by all subordinates who do not happen to be natives of the place. The prevalence of the disease is not due here, as it is elsewhere, to the presence of stagnant water, which indeed is singularly absent except in the rains. Its heaviest incidence is in the cold weather, when the rice-fields and

most of the smaller water-courses are dry. It is to be ascribed rather to the extreme diurnal variation of temperature in the deep ravines and valleys. In January the temperature in the lowlying shut-in parts rises to very considerable heights at midday and after, and falls rapidly at night to below freezing point. In proof of this it is possible in such places at that time of the year to find definite crystals of hoar-frost on the ground in the early morning. The people who live in these places, and who are without the means of protecting themselves properly against the cold, are the chief sufferers, and in turn infect others.

The new Plan, which although not a 5-year one has already been in operation over that period, has made a considerable difference in housing and communications. From the administrative point of view alone the improvement is remarkable. A complete tour of the area can now be made without returning to headquarters, as used to be necessary, or even without coming above ghats. By the middle of the present season it is hoped that there will be no less than nine *pukka* bungalows and five *kacha* ones (with tiled roofs and daub and wattle walls) all adequately equipped with furniture, to ring the changes on during the touring year.

So far so good. The beaten track is now more extended and contains more points *d'appui* for further exploration. But there is still a regrettably wide no-man's-land the condition of which from the point of view of present communication might be described under the vague caption of the old cartographers, " Here be Forests." Most of these places are at the foot of veritable canyons, remote and difficult of access.

The bungalows, on the other hand, are mostly sited on the highest ground available, which from the standpoint of health and scenery leaves nothing to be desired. But it is an unfortunate circumstance that the important works that form the *raison d'etre* of a bungalow's existence are generally situated at the bottom of valleys. An ancient poet has pointed out the contrast between the ease of the descent to Avernus and the difficulty of reascent. The comparison would not

SNAPSHOTS AT A BAYA NESTING COLONY.

1. Building cocks lustily join the frequent community choruses.

2. Two hens sometimes fight for possession of an eligible nest.

3. A Baya shooting up the entrance-tube is a pretty sight.

4. Cocks often continue prolonging entrance-tubes of occupied nests.

be inapplicable to a morning's work in Peint, when one sallies forth tripping blithely down the *khud*, roseate with *chota hazri* and morning pipe, only to reclimb it in the midday sun, foot by panting foot, "larding the lean earth at every step!"

One cannot close without referring to the peculiar position of the Forest Officer in Peint. There he is truly translated. In addition to his proper duties he is invested with the control of Revenue and Excise. The former is no sinecure, for there are about 240 villages, most of them in remote places, to be visited, and a considerable increase of office work. The arrangement is no doubt a sound one from the administrative point of view. In such a mountainous region no regular Assistant Collector, with other talukas to attend to, could expect to see a fraction of the country that the forest officer visits in the course of his regular duties. It is also a valuable experience for the forest officer. Any tendency to stress unduly the interests of his own department is checked by the obligations imposed by his dual rôle. He is forced to approach problems from more than a single angle. From time to time Dr. Jekell, the D.F.O., must oppose the policy of Mr. Hyde, the Assistant Collector, and Mr. Hyde refute the arguments of Dr. Jekell. But these dissentions, in the nature of things, are seldom acrimonious, and do not find their way on to record! The inspection of villages and crops, wells and schools is often a welcome variation from the monotony of coupes. Pope held that the proper study of mankind was man, and certainly a blend of sociology with silviculture makes for the better understanding of the latter, if not *vice versa*.

MAINLY IN QUEST OF FINN'S BAYA (*PLOCEUS MEGARHYNCHUS* HUME).

By Sálim Ali.

Kāládhūngi is a village in the Kūmaon Terai lying at the base of the Naini Tal ghat and along the old Morādābād-Bāzpūr-Kālādhūngi to the hill station route. Since the opening up of the Kāthgodām-Naini Tal road, the advent of motor transport and the consequent diversion of the seasonal traffic, the place has fallen on evil days;

tumble-down buildings and neglected compounds overrun with weeds everywhere tell the tale of departed prosperity. Another factor to discourage visitors is the unenviable notoriety the locality has acquired for malariousness, a charge which from personal experience I can fully endorse. As at present, therefore, Kālādhūngi presents no particular enchantment for the normal human being. I use the qualification advisedly as not all my friends will concede that an ornithologist comes under that category!

I visited Kālādhūngi on 15th September 1934. Leaving Naini Tal on foot at 2 in the afternoon, we reached Kālādhūngi Dâk Bungalow (17 miles) at 8-30 P.M. The path towards the end degenerated into a colourable imitation of a boulder-strewn ravine, and as the bulb of the only electric torch accompanying the party had timed itself to fuse just when we were at the darkest and least pleasant part of the journey, it can be imagined that the going thenceforward was not of the smoothest. Add to this pinching shoes and the sundry minor discomforts that invariably attend a party on the march, and you have a complete account of the journey.

The chief object of the visit was to try and obtain specimens, discover nesting colonies and study the breeding biology of Finn's Baya or Weaver Bird, a species of which our knowledge is practically nil. I shall give a description and history of the bird further on in the hope of interesting some of my readers with better opportunities than I had to fill the lacuna. I take this opportunity of expressing my thanks to Mr. S. Asadali Anvery, I.F.S., for the great trouble he took in arranging for my stay at Kālādhūngi and for the necessary facilities in my quest. At my request instructions had been sent on in advance to Forest Guards and others to mark down all weaver-bird nesting colonies in the precincts of the village in the hope that one or the other of them might, with luck, prove to be of the wanted species. These were visited in turn and during the next three days a good deal of the neighbouring country was ransacked for others. All the colonies located about the village and cultivation turned out to be those of the Common Weaver Bird or Baya [*Ploceus philippinus philippinus* (Linn).] They were mostly small, consisting of from a

single to four or five nests, suspended on *Acacia*, *Cedrela toona*, *Holoptelea* or *Dalbergia* trees of moderate size at heights of from 8 to 15 feet, and usually in the neighbourhood of paddy cultivation. Paddy leaves constituted the favourite building material in this locality.

In the course of one of my wanderings in open scrub country some 7 miles from Kālādhūngi, in what was apparently an old clearing for cultivation but now thickly overgrown with *Lantana* bushes, I came upon two large *Dalbergia* trees which presented an unforgettable sight. They stood with 150 yards of each other and their branches from the lowest to a height of 30 feet or more were thickly draped with the pendulous retort-shaped nests of the Baya, which hung all round the tree indiscriminately. It has been observed elsewhere that as a general rule where Bayas start building operations at the commencement of the S. W. Monsoon, a marked preference is exercised for the eastern side of the tree. The significance of this is clear : the leafy top of the tree coming between the nests and the prevailing south-westerly winds acts as a bulwark against the severe gales which are apt to blow at this season.

On one of the trees I counted over 250 nests, the largest number I have yet seen in a colony, while the other hung well over a hundred. Of the former over 160 were completed nests with entrance tubes varying between 9 and 18 inches long, and many of them contained young as evidenced by the females continually flying in and out with food. The country for a mile or more around these two trees was dotted over with smaller or " overflow " colonies of 2, 3, 4 or 5 nests each, hanging on small *Acacia* or *Dalbergia* trees—these mostly on the leeward side.

A couple of hours spent in watching a Baya nesting colony cannot fail to repay the bird-lover. There are many problems relating even to some of our commonest birds which await solution at the hands of the patient and critical bird watcher in the field and which no amount of museum study will elucidate. It was just such an opportunity I had of having a colony under close observation for several months that revealed the most interesting facts described in an

article on the breeding biology of this species in the *Journal of the Bombay Natural History Society* (Vol. XXXIV, pp. 947—964).

In many respects my observations were contrary to the accepted explanations copied from book to book by successive writers in the past and some of them unfortunately perpetuated even by such an eminent authority as Mr. Stuart Baker in Vol. III of his "Nidification of Indian Birds," published subsequent to my article. While it is admitted that the last word has yet to be said on a number of points, many of my findings have since been amply verified by myself and confirmed by independent observers. For the benefit of those who have not seen the article, and in order to stimulate further enquiry, it may not be out of place to give a brief summary of my conclusions :

1. Contrary to the old accepted belief that both sexes share in the building of the nest, it was found that the male is chiefly, if not wholly, responsible for this and that the female helps only occasionally and at a late stage in the construction with what may be called "interior decoration."

2. The males are polygamous, but not in the ordinary way. They build several nests in succession each of which when nearing completion (in some cases even when only half built) is visited by one of the prospecting females that habitually hang about the nesting colonies. In the event of the nest being approved by her, the female establishes possession and thenceforward becomes one of the owner's seraglio. When the nest is completed and this female settled on eggs, the male begins another nest somewhere in the neighbourhood of the first. If this is also taken up in due course by another roving female, the male will complete it and most probably begin on a third nest and sometimes even on a fourth. Nests not approved and unappropriated by females remain half completed, or in some cases the building "mania" of the male subsides before the last structure reaches a sufficiently advanced stage. The view that these half built-nests are made by the cocks as shelters for themselves and to sleep in at nights is not borne out by facts. At night the cocks do not sleep in the nesting colonies at all, but remove themselves to their usual community roosts among reedbeds and the like.

Two important points need still to be explained in connection with this species: (1) The reason and significance of the pellets of mud almost invariably stuck in the interior of the nests, and (2) the origin and significance of the common practice of suspending the nests over water.

So much for the Common Baya.

About 12 miles from Kālādhūngi and 3 before reaching Bāzpūr the Terai proper begins. Much enquiry revealed that a second species of Weaver Bird occurred in this locality which built its nests among the clumps of tall, coarse grass. The information was intriguing, and with the help of a guide from the local hamlet, we soon reached the spot indicated. Unfortunately on the previous day the villagers had organised one of their community hunts for the eggs and young of this species, which it was surprising to learn, they greedily ate! The villagers believe that Bayas do such enormous damage to their paddy crops that these periodical pogroms are only in the nature of a just retribution. While Bayas and the finch tribe generally admittedly do a certain amount of damage to ripening paddy crops on occasion, the credit side of their account represented by the enormous good they do in the destruction of injurious and fecund insect pests, especially during the period of rearing their young, is completely ignored. A minor digression may here be permissible. It is one of the greatest drawbacks in this country that all regulations and measures for the protection or otherwise of birds are based more or less on purely hypothetical data, without regard to any ascertained economic status of the species involved. A study of Economic Ornithology based on scientifically conducted field and experimental research is one of the most important and urgent needs of Agriculture, Forestry and Wild Bird Protection in India, and the Government of Bombay is to be congratulated on its far-sightedness in recommending financial aid to a recent scheme for such investigations to the Imperial Council of Agricultural Research. The issues are of such a complex nature that without the most careful scientific consideration, the wisdom of every big interference with birds, whether in the way of fostering

or of elimination is highly doubtful. Everything in the way of artificial wholesale elimination is of course to be strongly deprecated : before having recourse to drastic measures of interference it is imperative that man should get at the facts of the economic status of the species concerned, and of its exact ecological inter-relationships.

The crusade of the day before had left little hope of our finding any more nests in the vicinity, but fortunately a few isolated examples here and there had escaped the vandals. These were mostly suspended over a small meandering irrigation channel that intersected the country, among tussocks of tall, coarse grass on either bank that bent over and met to form a sort of bower over the water. In structure these nests closely resembled those of the Common Baya, but lacked the long woven stalks on which the latter are usually suspended. Instead, the coarse grass-blades were worked into the upper part of the dome. Some of the entrance tubes were well over 18" in length. There were a few agitated males present about the nests which proved to be of the Black-throated species, *Ploceus benghalensis* Linn.

All further search for the elusive Finn's Baya proved unavailing, and the trip ended without eliciting any workable clue to the whereabouts of the species. Unfortunately, we have no exact details concerning the biotope where Hume's original specimens were obtained. Since, however, the birds were found in the "Terai," it is suggested that for future efforts Bāzpūr may perhaps prove a more suitable base than Kālādhūngi which is primarily Bhabar country.

A Brief Account of Finn's Baya.

Sixty-nine years ago, *i.e.*, in December 1866, A. O. Hume, the celebrated ornithologist (and incidentally one of the founders of the Indian National Congress !) obtained at "Kaladoongi" two unique examples, both females, of a weaver bird which he described as a new species on page 406 of the "Ibis" for 1869, and named *Ploceus megarhynchus*. They were recorded as differing from the larger billed Nepal, Sikkim, E. Bengal and Burmese specimens not only in size—being much larger—but also in the darker and more rufescent tone of the entire plumage : in the almost entire absence of striations on the

crown ; in the much broader and sparser striations of the back ; in the entire absence of any rufous or rufescent supercilium ; and lastly in having the cheeks and ear-coverts unicolorous with the rest of the sides of head and nape (*Stray Feathers*, Vol. vi, p. 400).

Since that time nothing further was heard of the species until about the year 1901 when Frank Finn, then a Superintendent in the Indian Museum, discovered in the Calcutta live birds market some curious weavers of enormous size which he kept in captivity and watched going in and out of winter plumage. He stated that he had seen Hume's original specimens in the British Museum with which they agreed. As this, however, was evidently a comparison from memory only, there still remained a doubt as to whether *Ploceus megarhynchus* was really a distinct species or whether it merely had for its basis abnormally large examples of *Ploceus phillippinus burmanicus* Ticehurst, the Eastern Baya.

Finn's description of his supposed male *P. megarhynchus* in breeding plumage from the captive birds in his possession, copied by Mr. Stuart Baker in the 2nd edition of the Fauna of British India, Birds (Vol. iii, p. 69) reads as follows : "Adult male in Summer. General colour bright yellow (brightest on head and dull and impure on rump), with the following exceptions :—lores, round the eyes below, and ear coverts dark brown ; upper back, wings and tail blackish brown, each feather edged, entirely or externally, with light brown, on the uppermost part of the back with yellow ; under wing coverts dirty white." With regard to its distribution, Mr. Baker writes : "Hume's birds were obtained in the Kumaon Terai but since then nothing more has been learnt about this Baya's habitat until Mr. H. V. O'Donel discovered them breeding in the Buxa Duars and obtained a series of skins which he presented to the Bombay Natural History Society. It seems, therefore, that this species is a form inhabiting the lower Terai from the Plains to some 3,000 or 4,000 feet."

Commenting on the above, Mr. Hugh Whistler (*Jour. Bom. Nat. Hist. Soc.*, vol. xxxvi, p. 833) writes : " . . . I am not able to accept the suggestion (*New Fauna*, iii, p. 70) that *megarhynchus* breeds in the Duars. All specimens thence in the British Museum, as well as others

collected by Mr. H. V. O'Donel and Mr. Inglis and given or loaned to me belong beyond dispute to *burmanicus*. The series of skins presented to the Bombay Natural History Society can no longer be traced in their collection."

Subsequent to this, at my request, a further search was made among the Society's collection with the result that the following four specimens presented by H. V. O'Donel were brought to light. The particulars of these are as follows :—

1. (Breeding plumage) 17-5-25 Hasimara 500′.
2. (Breeding plumage) 31-5-25 Rajabhatkhawa 300′.
3. 25-5-12 " Bhutan Duars."
4. 26-6-25 Rajabhatkhawa 300′.

This material was kindly examined and compared for me by Mr. Whistler who reports as follows : "In the *New Fauna*, vol. iii, p. 70, Stuart Baker gives no date for O'Donel's breeding colony, but in *Nidification*, vol. iii, p. 4, he gives the year as 1912 and says that some of the specimens from that colony were sent to Bombay. He also says clearly that O'Donel was never able to visit the colony again and that no one since 1912 has seen the bird in its breeding haunts. No. 3 above, therefore, is the only evidence for the breeding of *P. megarhynchus* in the Duars. This bird is evidently the basis of the description of the breeding female on p. 70 as it is unusual in colouration. The crown and nape and sides of the face are olive brown, strongly washed with yellow and practically unstreaked, these parts contrasting with the rest of the upper plumage. The chin, throat, breast and flanks are largely canary yellow. In all other respects the bird agrees entirely with the rest of the series and I have no doubt that it is the same form. I have a female of *Ploceus philippinus philippinus* which has much yellow on it of a similar type and this evidently merely means that some particularly vigorous females assume an incipient breeding plumage. This particular specimen on which rests the authority for the breeding of *megarhynchus* in the Duars measures : bill from skull 20·5, wing 74, tail 54 mm. In other words it agrees with the rest of the series and they in measurements

and colour are quite definitely nothing but *Ploceus philippinus burmanicus*."

It is obvious that Mr. Baker's remarks as to altitude under "Distribution" are also incorrect. By "Terai" is usually meant the low-lying, often swampy, country covered for the most part with tall coarse grass, which stretches along the base of the Himalayan foothills and has an elevation of under 500 feet as a rule. I cannot help thinking that Mr. Baker uncritically misread the altitudes given on O'Donel's labels.

Finn's two live birds, described and figured in colours in the "Ibis," 1901 (page 29) were evidently still living at the time and what became of them subsequently was not known. Through the good offices of the Director, Zoological Survey of India, I think we have succeeded in getting to the bottom of the mystery of the whereabouts of at least one of Finn's specimens. In the Indian Museum, Calcutta, there is a skin (Reg. No. 24746) which was kindly lent me for examination. It bears a label of the Zoological Society's Gardens, Regent's Park, London, N. W., with the following particulars: "Country: Naini Tal; Sex ♂; Received 18-6-01: Died 1-7-04." It measures as follows: Bill 20·5 (22·5); Wing 83·5 (83·5): Tail 56 (58) mm. The figures in brackets are the measurements obtained by Mr. Whistler who was good enough to have the Calcutta specimen compared for me with Hume's originals in the British Museum. The discrepancies are what is to be expected in measurements taken by different persons, but we agree in respect of the wing which is the most important item.

Mr. N. B. Kinnear, who actually did the comparing, confirms that the specimens agree in size* and might very well pass as male and female of the same bird, so we may take it that Finn was correct in his assumption that his captive specimens were males of *Ploceus megarhynchus* alright. The Indian Museum specimen agrees well with the coloured plate in the "Ibis" except that the sides of the head and neck are more suffused with brown in the skin, and the ear-coverts and spots on the side of the neck are not so dark.

* Mr. Whistler measures Hume's original specimens as follows: Bill from skull 21·5 (type) and 22; wing 77 and 80·5; tail 56 and 59 mm.

In view of the above and as it is now certain that O'Donel's breeding colony of the Duars was not of this species but of *P. philippinus burmanicus*, it will be seen that the ground has slipped from under our feet and we are left absolutely in the dark as regards the distribution, habits and breeding biology of *Ploceus megarhynchus*. The last 34 years have added nothing either in the way of specimens or knowledge concerning the species, and it is to be hoped that this note will serve to induce residents in the Kumaon Terai to endeavour to supply the deficiency.

COCKCHAFERS AND CONIFERS.

BY C. F. C. BEESON, FOREST ENTOMOLOGIST.

The dying-off of seedlings and young plants of conifers (particularly deodar) in the western Himalayas has generally been ascribed to the activities of cutworms and cockchafer grubs. The cutworm involved is usually referred to as *Agrotis ypsilon*, a widespread species found in all continents, while the cockchafers have been somewhat vaguely identified as *Melolontha* sp. (on the authority of Stebbing, 1914, Indian Forest Insects, p. 82) and more recently as *Protætia neglecta*, a cetonine.

Although our investigation of the importance of cutworms is not complete it appears that damage from this agency is limited to the young seedling and to a period of a few weeks in the spring immediately after the snow has disappeared from the seedbeds. See note by Gardner in previous issue on pp. 327—329.

Damage that has been assigned to cockchafer grubs affects the seedling and transplants up to three years old and has been recorded in divisional forest records and working plans as varying between wide limits; recent estimates in deodar nurseries, for example, are: Hazara, 1 to 10 per cent; Kulu, inappreciable to 70 per cent; Seraj, 10 to 70 per cent; Upper Bashahr, 35 to 100 per cent; Chakrata, 40 to 60 per cent. As a result of biological investigations made in Kulu, Punjab, in 1934 and in Chakrata, United Provinces, in 1932-34, cockchafer grubs occurring in the soil of coniferous forests have been

identified and new light has been thrown on their economic importance in connection with the dying-off of seedlings and transplants.

Species of Cockchafers.—In Kulu and Chakrata some 47 species of cetonine, melolonthine and ruteline larvæ were discovered at the localities sampled between 3,000 and 9,000 feet elevation. Of these species 17 actually occurred in seedbeds in forest nurseries or in the soil between beds. They are:—*Adoretus stoliczkæ*, *Adoretus* sp., *Anomala lineatopennis*, *Anomala rufiventris*, *Anomalini* sp., *Brahmina coriacea*, *Brahmina* sp. F, *Granida albosparsa*, *Granida* sp., *Hilyotrogus holosericea*, *Hoplia adrena*, *Lachnosterna longipennis*, *Melolontha furcicauda*, *Mimela pectoralis*, *Popillia cyanea*, *Serica umbrinella*, *Sericini* sp. The common day-flying *Protætia neglecta* although seen on the wing in nurseries was not found as larvæ in the soil.

The largest species of cockchafer grub occurring in seedbeds (in Kulu) is *Granida albosparsa*; this insect also lives in soil varying from poor micaceous earth to black humus, carrying grass or weeds and occurs up to 9,000 feet in open or lightly shaded places in high forest as well as in cultivated land lying fallow. Other species characteristic of seedbeds are *Melolontha furcicauda* and *Mimela pectoralis*.

Damage in Seedbeds.—In nurseries cockchafer grubs do not occur in new beds prepared after the monsoon, but oviposition takes place in beds worked up in July or in June. If transplants are removed in July and the beds are resown in December, the grubs carry over the fallow period in the organic matter and dead rootlets in the soil. Oviposition apparently does not take place in raw mineral subsoil and beds made of such soil are ordinarily entirely free from cockchafer damage.

The larvæ of *Granida* and associated species of cockchafers cut through the taproot of seedlings at any point from just below soil-level to two inches deep. A considerable section of the root disappears and is presumbly eaten. Damage by grubs begins in April and is most severe during May. In seedbeds at Manali, Kulu Division,

where mortality could be ascribed almost entirely to cockchafers, it was observed that deodar seedlings were reduced by 20 per cent. during April and by a further 40 per cent. during May. By the middle of June the larvæ are beginning to pupate, and subsequent mortality depends mainly on the ratio of surviving seedlings to larvæ.

Cockchafer damage in coniferous nurseries is, however, very irregular in its distribution. It is often concentrated in a few adjacent beds and whole sections of a nursery may be completely immune. Moreover, in most localities, a half to almost the whole of the mortality among seedlings can definitely be ascribed to causes other than insects. A seedling of pine or deodar killed by cockchafer grubs may be distinguished from one dead from other causes by the fact that it may be withdrawn from the soil by a vertical pull requiring very little force. Seedlings dying from other causes obviously break when pulled.

Damage to Seedlings in Regeneration Areas.—In the patch sowings of regeneration areas in Kulu, examined in June 1934, in no case was a seedling found damaged by insects and no larvæ of cockchafers or cutworms were found in or near sown patches. The usual symptoms of death are drying-up of the taproot before rootlets are formed and the presumed causes are drying-out of the soil, competition in thick sowings, obstruction by stones and insufficiently dug subsoil, burial by slipped soil and stones, trampling, and tops bitten off by animals. Damage by cutworms takes place early in the year.

Damage to Transplants.—Neither in nurseries or in regeneration areas have we encountered serious damage to transplants by cockchafer grubs. In Kulu, dead or dying transplants were found to have made no growth since planting out. The root-system was observed to be in exactly the same stage as when removed from the seedbed eleven months previously.* The side roots die quickly and the taproot more slowly until the die-back reaches a point below soil-level where there is a sharp demarcation between dead and living tissue. Some

* This deduction was most readily made in the case of plants derived from a nursery with yellow soil and transported in wet mud and put out in black soil.

callus may be produced at this point and the formation may easily be mistaken for cockchafer damage, but it can be diagnosed with certainty as die-back from the fact that the primary cuticle extends unbroken from the living stem to the shrivelled dead portion. Some plants may survive this stage and send out new roots from the callused termination of the living stem : such plants would later on probably be diagnosed as bitten off by cockchafer grubs. A young deodar plant with dead roots undoubtedly retains its needles green for nearly a year but can be distinguished from a healthy plant in that it does not produce branchlets or open its buds.

In Chakrata Division investigations showed that the dying-back of roots of *deodar* was often due to injuries at the time of transplanting. In a few cases fresh damage by grubs was observed but in these only the living green bark near the upper part of the root was gnawed. Cockchafer work was responsible for not more than 13 per cent. of the total mortality and no insect damage was observed on healthy plants.

Conclusions.—It is concluded that soil insects are of much less importance than other factors in causing the death of conifers between the ages of 6 and 30 months, and that the liability to damage is not high enough or general enough to warrant special insect control measures. The remedy for mortality among transplants lies in improvement or proper application of cultural methods.

In seedbeds, on the other hand, control measures against cockchafer grubs are required in those localities where the mortality of seedlings is definitely proved to be due to grubs. It has been mentioned above that seedbeds prepared and sown up in November or December are immune from appreciable losses provided the soil of such beds has not been worked in the previous June and July. In the case of monsoon sowings, measures are necessary to prevent oviposition in soil worked up during the flight period of the beetles. Experiments are in progress to determine if top dressing the soil is effective against oviposition and if readily obtainable materials can be put to practical use.

THE MARKETING OF TIMBER AT DORAHA.

By Khem Chand, E. A. C. Forests.

I.—Introduction.— Doraha is a railway station in Patiala State territory, on the Lahore-Ambala main line, at a distance of 14 miles from Ludhiana or 57 miles from Ambala. It lies on the left bank of the Sirhind Canal, 36 miles from Ropar Canal Head.

II.—Import.— The total volume of business handled at Doraha is indicated by the quantities of timber imported into Doraha annually, as the same have to be disposed of each year.

Timber trade at Doraha is carried on in *deodar, kail, chil* and *fir* alone ; and the sources of import are ; (*A*) hill forests by the Sutlej *via* Sirhind Canal, and (*B*) other timber markets by rail—the total average annual import comes to 8 lacs cu.ft. timber, including some 10,000 cu.ft. of round timber.

(*A*) *The Sutlej River.*—All timber launched into the river from hill forests is bound into rafts at Handola boom and then floated down to Doraha *via* Sirhind Canal.

The Canal Department charges the following "navigation" fees for all timber rafted from Ropar to Doraha :—

Class I.—All round and sawn timber (excepting B. G. sleepers) of girth 30″ and over @ -/-/9 per 100 cu.ft. per mile.

Class II.—All round and sawn timber (excepting M. G. sleepers) of girth under 30″ @ -/-/4 per 100 cu.ft. per mile.

Class V.—B. G. sleepers @ -/3/- per 100 sleepers per mile.

Class VI.—M. G. sleepers @ 7½ pies per 100 sleepers per mile.

Every agency rafts down its own timber at its own expense. The traders' timber that goes adrift *en route* is collected and transported to the catching depots or Doraha by the Government Forest Department through its contractor. It is later released on payment of salvage fees under Chapter VIII of Indian Forest Act XVI of 1927.

The following expenses are incurred by the Government Forest Department and traders on catching, collection from "chhandas," tying, rafting, landing, classification and stacking in the depot, etc., over and above the rafting fees payable to the Canal and Forest Departments :—

(*a*) *Round timber* :—

Over 5 cu.ft. @ -/1/9 per cu.ft.

Over 2½ cu.ft. and up to 5 cu.ft. @ -/2/6 per piece.

2½ cu.ft. or less @ -/1/6 per piece.

(*b*) *Sawn timber* :—

Over 8 cu.ft.	@ -/1/-	per cu.ft.
,, 6 ,, and up to 8 cu.ft.	,, -/4/-	each.
,, 5 ,, ,, ,, ,, 6 ,,	,, -/3/-	,,
,, 2½ ,, ,, ,, ,, 5 ,,	,, -/2/3	,,
2½ cu.ft. or less	,, -/1/6	,,

The following agencies import timber into Doraha by water to an average total of 5¼ lacs cu.ft. plus some 10,000 cu.ft. of round timber annually :—

1. *Government Forest Department.*—Previous to 1933-34 nearly 1½ lacs of scantlings, equalling 3½ lacs cu.ft., besides nearly ½ lac cu.ft. of round timber, used to be imported from the leased forests of Rampur-Bashahr State. But since then departmental exploitation has been reduced to a little more than half a lac of scantlings, equalling over 1½ lacs cu.ft. plus some 10,000 cu.ft. of round timber. Government Forest Department is the only agency to bring round timber into this market.

Rafting from Handola and landing and stacking at Doraha are done through contractor. The ghal arrives at Doraha usually in October to December and is sold forthwith with a view to avail of the comparatively high market-prices prevailing at that time of the year.

2. *Mandi State.*
3. *Forest Lessees.* } Besides the fee of Rs. 5/- for registration of one property mark and Rs. 10/- per mark for registration of more than one mark, all traders (including Native States) have to pay to the

Government Forest Department the following rafting fees for use of the river between Handola Boom and Ropar Canal Head :—

For scants 3 cu.ft. and over in volume = -/-/6 each ; and

For scants under 3 cu.ft. in volume = -/1/- per 100 scants.

The major portion of their timber reaches Doraha during November to April and is imported from leased forests in Government and foreign territories in variable quantities each year as disclosed by the following tabular statement of the number of scantlings imported by these two agencies during three years :—

	Deodar	*Kail*	*Chil*	*Fir*	*Total*
1932-33 ..	68,227	21,776	22,216	5,169	1,17,688
1933-34 ..	10,868	11,562	62,389	520	85,339
1934-35 up to March 1935. ..	91,388	53,294	1,05,015	41,223	2,90,920

This gives an average of a little over 1½ lacs of scantlings or 3¼ lacs cu.ft. of timber. The import in 1934-35 is unusually high due chiefly to 83,000 scantlings exploited by Messrs. Harikishan & Co. from Suket State. The major portion of the timber imported by the forest lessees (traders) comes from foreign territory including Kutlehr, Bashahr, Suket, Kumar Sain, Madhan and Mandi States; and the balance is the outturn of standing trees sold in Hoshiarpur, Bashahr and Seraj Forest Divisions of the Government Forest Department.

(*B*) *Import by rail* :—Traders alone import timber by this means, practically all of which is meant for local consumption and consists of large-sized *chil*, and to a lesser extent *fir* sawn timber transported from the following timber-markets :—

(*i*) Dhilwan.
(*ii*) Jagadhri.
(*iii*) Hardwar.
(*iv*) Tanakpura.
(*v*) Jhelum.

The total average annual import by this means amounts to 66,000 scantlings or 2,61,000 cu.ft. of timber. The Railway registers show an annual average import of 1,44,000 maunds of timber,

bringing an earning of Rs. 30,000/- to the Railway Department as freight charges. The railway records also show that there is rush of arrivals by rail during February to June (when *chil* market abroad is down) and during the slack (July to August) season.

III.—Export.—The total value of timber imported annually to various places such as Ludhiana, Jullundur, Phagwara, Phillaur, Amritsar, Ferozepore, Jagraon, Patiala, Badhni, Moga, Hoshiarpur, Rupar, Sangrur, etc., is about Rs. 7 lacs. It consists of :—

(*a*) Export by Sirhind Canal below Doraha to the extent of 15 per cent. of the total receipts, or roughly 1,15,000 cu.ft. This export goes on throughout the year: but there is rush during "Asuj" and "Kartak" (middle of September to middle of November). The Canal Department charges navigation fees for floating of timber below Doraha as follows :—

Class I.—All round and sawn timber (excepting B. G. sleepers) of girth 30″ and over @ -/-/6 per 100 cu.ft. per mile.

Class II.—All round or sawn timber (excepting M. G. sleepers) of girth less than 30″ @ -/-/3 per 100 cu.ft. per mile.

Class V.—B. G. sleepers @ -/2/- per 100 sleepers per mile.

Class VI.—M. G. sleepers @ -/-/5 per 100 sleepers per mile.

(*b*) By cart (*i*) to timber merchants at Ludhiana, Phillaur, Phagwara, etc., roughly 10 per cent. of the total receipts, or 77,000 cu.ft. Cartage is paid @ -/3/- per mile for a cart-load of 30 sleepers. (*ii*) Local consumption in the neighbourhood of about 25 per cent. of the total receipts, or 2,74,000 cu.ft. of timber (mostly large sized *chil* and *fir*).

(*c*) Export by rail to the extent of 50 per cent. of the total receipts, or 3,31,000 cu.ft. This includes 20,000 B. G. sleepers Railway I class=68,000 cu.ft. transported by the N. W. Railway itself.

During 1933 and 1934 the railways earned Rs. 13,816/- and Rs. 15,575/- respectively as freight charges.

The railway records indicate rush of export from February to June and slack season from July to September.

Railway Booking.—Railway freight is charged by the N. W. Railway on booking of timber under the following schedules :—

i. Schedule C. R.—

(*a*) Charge is made for a closed wagon @ ·14 pie per maund of its conveying capacity per mile up to 150 miles, and @ ·11 pie per maund per mile for the distance over and above 150 miles : plus 2 pies per maund as terminal tax and 3 pies per maund as "short distance charge" in case the distance is below 74 miles.

(*b*) For an open truck, charge is made for a fixed quantity of 400 maunds at the above mentioned rates.

ii. Schedule C. B.— For open consignments smaller than a full
C. K.
wagon-load, charge is made at ·38 pie per maund of the actual weight per mile, plus -/-/6 per maund as terminal tax and -/-/3 per maund as "short distance charge" for distance below 74 miles.

Note.—Since the Railway Department records only the maundage and not the number or volume of timber consigned, the following tips may be found useful :—

Seasoned	*deodar*	weighs	18	srs. to a cu.ft.	Average of all species combined=18 seers per cu.ft.
,,	*kail*	,,	16	,, ,, ,, ,, ,,	
,,	*chil*	,,	20	,, ,, ,, ,, ,,	
,,	*fir*	,,	16	,, ,, ,, ,, ,,	

While unseasoned timber (all species combined) weighs 55 mds. per 100 cu.ft. or 22 seers to a cu.ft. on the average.

Government Depot.—General arrangements :—

(*a*) *Site.* The Government depot site is a flat, grassy area rented from the local zamindars and situated at a distance of 3 furlongs from the railway station adjacent to the Sirhind Canal. Railway siding for the Canal Department runs alongside of the depot and is open to the Forest Department and its customers for use @ Re. 1/- per wagon.

(*b*) *Stacking of Timber.*—Soon after landing from the canal, the timber is classified and stacked in close crib manner separately for each species, sizes and quality-classes (excepting the departmentally passed railway sleepers which are now coal-tarred at ends and then stacked under "1 in 9" method). The logs are arranged in rows. Each lot is serially numbered and often separately sold. Lanes 3′ wide are left between the stacks (usually grouped into four) to allow inspection and branding with sale-hammer before removal. Number of scants in a stack varies according to their size. Usually 100 B. G. sleepers are contained in one stack.

(*c*) *Classification.*—Round timber is classified according to girth separately for each length class, according to length separately for each quality class and according to quality separately for each species. While sawn timber is classified according to quality separately for each size and species.

Quality in timber is a complex of factors and comprises the following main characteristics:—

(*i*) Freedom from knots—particularly the big, loose and group of knots which seriously affect the strength and appearance of timber.

(*ii*) Freedom from cracks, splits and fractures.

(*iii*) Absence of rot and insect-attack.

(*iv*) Full size and sharp edges.

(*v*) Straight fibre and fine beautiful grain.

(*vi*) Absence of sap-wood.

Both size and quality determine the price of a particular species of timber. The larger the size, the greater will often be the price per cu.ft.

"Rejected" timber is that in which a through crack extends lengthwise beyond the middle point, or which is rotten, fractured or so knotty or otherwise defective as to waste more than half of its volume.

V.—Public Timber Market.—General arrangements:—

(a) *Site.*—Until 1923, the public timber market was situated between the Government Depot and Railway line on rented land.

But since then it has been shifted to the other side of the Railway line in close proximity to the grain market. The new site was first acquired by the State Durbar from zamindars and then sold to timber traders in plots (300′×200′) regularly laid out with roads. The traders have erected shops and dwelling houses on their plots, besides temporary sheds to store a limited quantity of the best quality timber for protection against the sun. This market lies quite close to the Railway station and is provided with Railway siding running alongside it.

Mandi State depot lies adjacent to the Government Depot, away from the Railway line.

(b) *Stacking and Classification.*—The systems of stacking and size classification are practically the same as described for the Government Forest Depot. But the quality classes adopted by traders (and Mandi State) are somewhat different, as discussed below :—

Forest lessees (locally called *Mohaldars*), who import their own timber by the river from leased forests, classify their timber into "Samudha" and "Rejected" lots for wholesale purposes. "R. R." forms another class in the depot of the "Mohaldars" who supply B. G. sleepers to the N. W. Railway.

Traders, on the other hand, adopt a double set of classification. For re-sale of timber purchased from the Government Forest Department, Mandi State and Forest Lessees, they retain the original classification as long as it is not removed. But if they carry any of the unsold balances from these depots to their own, they classify them into "Special", "I", "II", "III" and "Rej." for sale to retailers and consumers.

The following nomenclature would further illustrate classification based on size and quality of timber :—

(*i*) "Bingar lakri," denotes inferior quality scants, extracted from trees of small girth, and, therefore, having wane (round edges) and bark ("looti"—a Bashahr term) on two of its edges.

(*ii*) A scantling is called "choloaglā" (Bashahr term) if four of its sides are sawn, "tileaglā" if three of its sides are sawn, and "doleaglā" if only two sides are sawn. Sawn faces indicate better quality.

(*iii*) Karri with one or two sides sawn is called "Chirān gaz" in Bashahr. But if all its four sides are axe-cut, it is called "Pachhān bālā"; and if round, it is called "gol "bālā"! But locally all karries are called "gaz" or "bālā," and round ones are called "bāllā."

(*iv*) Scantlings of $8'' \times 5''$ section are called "Kamnap" sleepers locally, "Kamarpeti" in Bashahr.

(c) Labour arrangement.—

All labour in the timber market is controlled by mates locally called "Jamadars" each of whom has a gang of 20 to 40 coolies at his command and 3 to 7 timber shops in his jurisdiction for execution of all work of stacking, turning over (locally known as "paltāi") scants for classification, carriage and cartage, landing, launching in the canal for export, loading, etc. on job rates. There is no legal obligation on the part of the "Jamadar" to execute all the work of a trader whenever called upon to do, or on the part of the trader to allocate all work of his depot to any one "Jamadar" for execution. But, with rare exceptions, the obligations on either side are customarily fulfilled without default.

The job rates in force are as below :—

(*a*) Landing from the canal, carriage to and stacking at the Mohaldar's depot @ Rs. 2/8/- to Rs. 3/8/- % sleepers according to the load.

(*b*) Stacking or restacking after turning over ("paltai") in the depot @ -/8/- to -/10/- % sleepers.

(*c*) Loading in cart @ -/-/3 per sleeper.

(*d*) Cartage @ -/3/- per mile for a cart-load up to 30 sleepers.

(*e*) Loading railway wagons including carriage, @ Rs. 2/- to Rs. 3/- % sleepers according to load.

(*f*) Launching in the canal, including carriage, @ Rs. 2/4/- to Rs. 3/4/- % sleepers according to load.

VI.—Sales in Government Depot.

(a) Method and conditions of sale.

Sale of timber in the Government Forest Department depot is usually made by public auction, and rarely by private negotiations. Power to sanction all sales vests in the Conservator of Forests, E. C., Punjab: and he may, whenever he cannot personally come, depute the Divisional Forest Officer, Upper Bashahr Division, or any other officer, to hold the auction on his behalf and accept the highest bids on spot subject to reserved rates prescribed by him (Conservator of Forests). Auction is held as soon as some 15,000 scants, or unavoidably less are ready in the depot for the purpose, in order to avail of the higher market rates prevailing in the beginning of the season when stock of timber available in the market is comparatively small. Auction results are entered in the list of lots, previously prepared by the Depot Officer, immediately the highest or any other bid for a lot is accepted by the auctioneer. Each lot offered for sale may consist of a few logs or 100 scants or more or less, to enable both big and petty dealers to bid and the Government to realize the maximum possible rates.

Ten per cent. of the sale value of each lot is realized on spot, and the balance within one month. Removal of the timber sold is allowed to the purchaser only against payment and after branding it with the departmental sale-hammer within one month of the auction. At the expiry of this period, depot rent (demurrage) is realized from the purchaser at -/1/- per log per day or -/-/3 per scant or other round timber per day. In the event of default, the timber is liable to be re-sold, and the balance, if any, is realized from the defaulter under Sections 82 and 83 of the Indian Forest Act. But these penalty clauses of the "sale terms" are seldom called in. And in the case of large purchases, period for payment and removal is often extended by way of facility in business.

(b) *Sale to other Government Departments.*—Some 15,000 to 20,000 sleepers are annually sold to other Government Departments, excluding N. W. Railway, by private negotiations.

Sale to N. W. Railway of railway I class B. G. sleepers is made under a "3 years' contract" at the following rates :—

10′ & 9′ deodar	sleepers	= Rs.	4/12/-	each.
10′ kail	,,	,,	3/9/6	,,
10′ chil	,,	,,	3/6/6	,,
10′ fir	,,	,,	2/13/6	,,

The sale terms are embodied in "The Railway Sleeper Contract." Immediately after removal from the water, the sleepers are departmentally sorted out for presentation to N. W. Railway. They are then at once coal-tarred at the ends before stacking. The stacks are protected from the sun. After 2 months, the Railway Sleeper Passing Officer inspects the sleepers individually. The rejections are later sold as "R. R. sleepers."

The specifications laid down by the N. W. Railway are as below :—

i. Stacking to be done under "1 in 9" method ;
ii. Boxed heart and annual rings perpendicular to the broad face are not permissible ;
iii. Not more than one tight knot up to 1″ diameter at the rail seat is permissible.

(*c*) *Sale rates.*—Standard sizes of timber are sold by number, and others by volume. As a rule, the bigger the size of a log or scant, the higher would be its price per cu.ft.

Appendix A shows averages of sale rates obtained at auctions in this depot during the current year for round and sawn timber. The prices have gradually risen for the past 4 years, this year's sale rates are a great deal better than those of the previous year and unusually better than those of the local timber market and other Government depots despite the notoriety of the defective timber that comes from Upper Bashahr. This may be attributed to good sawing, attractive depot arrangements and stacking of the timber immediately after removal from the water which give no chance to cracks and splits appearing by the time of the auction.

VII.—Sales in Mandi State Depot.—Head of the Forest Department of Mandi State, designated "Conservator of Forests," arranges all sales. He often makes forward whole sale of the main ghal by calling sealed tenders about a month before the timber arrives at

Doraha. Some 5,000 to 8,000 sleepers are annually supplied to N.W. Railway under the "Railway Sleeper Contract." The rejected sleepers (3,000) were later sold by the Conservator of Forests by private negotiations. The sale rates realized were 5 to 10 % below those of the Government depot. Total annual import by the State is discussed jointly with that of the traders.

VIII.—Sales in the Public Timber Market.

Note.—Nearly a lac of scantlings worth about Rs. 2,75,000/- during December to March, and ½ lac scants, worth Rs. 1,37,000/- during April to November are available in stock at all the depots combined (including Government and State depots) at Doraha.

(a) Method and conditions of sale in general :—

At present there are three firms of Forest Lessees (Mohaldars) who deal in wholesale disposal of their timber at Doraha. Of these the firm of Messrs. Harikishan & Co. is the biggest. Six other "Mohaldars" deal in wholesale as well as in retail business. Besides there are a dozen of traders who are mere retailers.

Wholesale transactions are made usually by auction or private negotiations and rarely by tenders. In the last case, "Cover system" of the grain markets is often adopted as a substitute for "sealed tenders." That is, the "Mohaldar" moves among the bidders gathered together on the date fixed for sale, and takes offers from them individually under cover of a piece of cloth by means of show of fingers which signify the sum of rupees, annas and pies, respectively, offered as purchase rate for a particular lot of timber. The "Mohaldar" finally announces the highest offer received by him under the "Cover" and which he wishes to accept. Some lessees also sell B. G. sleepers to N. W. Railway. Retail sales are made by open bargain.

(b) *System of brokerage and commission.*—Excepting petty sales to the local consumers, most of the transactions by private negotiations in timber trade here are effected through the agency of commission agents locally known as "dalals" (brokers) who are synonymous with "Kacha ártiás" of the grain markets, who are themselves traders (shop-keepers) besides. "*Pucci árat*" of the grain-market, in which case the *artia* invests money on behalf of the purchaser until the latter is able to pay up the dues, or advances more than 50 per cent. of the

anticipated sale proceeds to the seller, is almost unknown in the timber trade here.

The ordinary and usual rate of commission (brokerage) in force is ½ per cent. or -/8/- on a transaction of Rs. 100/- from each of the purchaser or seller. But it varies inversely with the amount of sale, from -/2/- to -/12/- per 100 rupees, and for all practical purposes, the seller includes the commission he has to pay in his sale rate, as he does in the case of all his other contingent expenses.

In very exceptional cases, however, a commission agent would invest part of the purchase-money on behalf of a very reliable, accommodating and old customer or client of his in getting him timber which happens to be out of stock in his (commission agent's) own depot. In such cases, the commission agent would be entitled to double the rate of ordinary brokerage from the purchaser. Double commission is also charged if the broker has also to look after his client's timber in the seller's depot and to re-sell it or to despatch it to him. In this case, the broker also plays the role of a *kachà āritiā* of the grain market.

There are four traders here who act as brokers as well as *āritiás* while all the other traders work as mere brokers. But, of course, the broker deals in commission agency over and above his own trade in timber.

(c) *Muddat.*—It is a sort of bonus which the seller allows to the purchaser for immediate payment of the price of timber ; and it varies from ½ to 1 per cent. of the value of the sale effected. The basis of this allowance is traceable to the fact that because the seller ordinarily expects payment from the purchaser in one month's time ; therefore, for immediate payment, he refunds to the purchaser the interest which the latter would have earned on the money in one month permissible under the usual business-etiquette. The usual rate of *muddat* payable to the purchaser for immediate payment is -/12/- per 100 rupees paid, being 9 per cent. interest rate per annum due for one month. In case the purchaser defers payment for more than one month, he has to pay interest to the seller at the current rate, *viz.*, 9 per cent. per annum for the period over and above one month.

In the case of deferred payment, the seller may allow removal of the timber on trust to the purchaser, or on assurance and responsibility of the commission agent (in the case of both small and big transactions by private negotiations). In the latter case, the commission agent would be entitled to double the rate of ordinary *arat*.

(d) *Karta.*—This too is an allowance, by way of discount, usually paid to purchasers by "Mohaldars" for defects in the timber sold. Ordinarily, it is payable @ 1% of the sale value, which means 1 scantling free out of the 100 sold. But a higher or lower rate may be settled at by negotiations before the transaction is concluded, as this allowance is, in reality, meant to compensate the purchaser for lower quality of some of the scantlings than that for which the whole lot is sold.

(e) *Retail sales.*—They are always effected by open bargaining through or without the agency of brokers. It sometimes happens that a customer, even though bent on making purchase independently, is accompanied by a clever broker merely on the pretext of friendly help in choice of quality-class or in obtaining concessions. And on arrival at the shop intended for by the customer, the broker will make a secret sign to the shopkeeper to signify his intervention as broker. Then, if the bargain matures, the broker would be entitled to his commission @ -/8/- per 100 rupees from the seller who will have already included it in his sale rate at the expense of the customer. Of course, the customer is unaware of all this. This practice of duping simple-minded customers is notoriously prevalent on a large scale at Benares, particularly in the cloth market. And the writer once happened to fall a prey to this trick there in 1921, but luckily escaped on deferring conclusion of the bargain with a view to compare prices of the cloth, and came to know of it later.

The customer often trusts the shopkeeper in the quality of the lot of timber presented to him; otherwise the stack is dismantled and scantlings are turned over for the customer to inspect them individually; and the cost on this labour is borne by the shopkeeper if the bargain holds good, failing which the customer bears the cost unless otherwise agreed to by the shopkeeper beforehand. No *karta* is

admissible in petty sales; and *muddat* may or may not be allowed by the seller.

(f) *Nature of local demand.*—

(a) *General.*—The neighbouring villages need chil most, fir to a small extent, but little of deodar and kail. This is because they cannot afford to spend a great deal all at once on the costly timber; and people living in *bet* areas (within reach of river flood) require to build more or less temporary houses for fear of their being washed away. They prefer chil to fir because the former is only slightly more expensive but much stronger and safer from white-ants than fir. White-ant is a terrible pest in this locality.

The country folk need large sized timber mostly for roofing, bed-arms, etc., hence the largest demand for beams and 12′ sleepers and *kamnaps* (other scants). For other sundry purposes they would go in for "III" and "Rej." class deodar and kail timber in preference to better even though only slightly more expensive quality classes.

(b) Reduction in sale price is not proportionate to the fall in quality of timber :—

It is an interesting point peculiar to the local market. It has been observed, for instance, that a B. class B. G. sleeper contains less than half of the valuable timber in A. class; and yet the B. class sleeper would fetch nearly 3/4ths of the price of A. class. Again "Rej." class B. G. sleeper is actually worth not more than 1/3rd of A. class sleeper; and yet the former sells at more than half the price of the latter. This can be accounted for by the following reasons :—

i. The country folk always prefer to pay a lower price although for a much lower quality.

ii. The village carpenters purchase "III" and "Rej." classes of deodar and other timber, as they can manage to make use of the smaller pieces obtainable by sawing, for furniture and other sundry purposes.

iii. Even the local timber traders readily purchase the lower quality classes with the object of mixing them up in lots of higher quality classes for sale at their shops. It is a trade-trick frequently indulged in here.

(c) There is no local demand for timber converted into smaller sizes and pieces ready for use in construction, furniture and other

miscellaneous purposes. Hence there are no workshops at Doraha for conversion of timber.

(g) *Sale rates.*—Due to indefiniteness about grading of timber which varies from trader to trader, sale rates are not standardised, and have to be settled by negotiations.

Appendix A gives the average of sale rates, obtained at auctions in the Government depot at Doraha during 1934-35 for each size and quality-class of round and sawn timber separately. And it may be safely asserted that the sale rates of "Mohaldars" (forest lessees) are nearly 10% lower than the Government Forest Department rates due to less care in sawing, classification and depot arrangements, and customers' lack of faith in the accuracy of quality classes and dealings of the traders than in those of the Government Forest Department; while the retailers' sale rates may be as much or up to 5 per cent. higher than those of the Government depot.

(h) *Trade disputes.*—There is no committee or panchayat appointed by the traders or the Patiala Durbar for the purpose of settling disputes among the traders or between a seller and a purchaser. But any such dispute may be referred to one or more of the other traders, at the option and choice of the parties concerned, for arbitration; or it may go to a court of law for decision.

The chowdhari of the timber mandi is nominated by the Patiala Durbar. But he acts like a village lambardar, and has little influence with the traders.

IX. Speculative Sales.—Speculative bargains are entered into but occasionally by wholesale dealers, wherein the seller contracts to deliver and the buyer to receive during a specified period (usually the anticipated time of arrival of the seller's ghal at Doraha) a certain quantity (with fixed minimum and maximum) of timber of specified kind, quality, class and size and at stipulated rates. Such forward sales are effected usually when either party is considered by the other to be accommodating.

This year Mandi State made forward sale o its ghal nearly a month before its arrival, through sealed tenders. Also Messrs. Khazan Singh Sobha Ram contracted in March 1934 to sell their ghal of K, S. S. R. marked timber (mostly fir) to a trader of Jagadhari at

stipulated rates subject to discount (*Karta*) for damaged ends and other unforeseen defects. This ghal was expected to arrive in March, 1935. That is, the bargain was entered into a year before delivery of the timber. Again, the Government Forest Department supplies sleepers to N. W. Railway under a "three years' contract" in which case sale rates are fixed up to three years before supply. In extreme though rare cases of contracts in "futures" a forest lessee first contracts to sell outturn from a forest open to lease and then purchases standing trees in the forest, basing his offer for the lease on the previously stipulated sale rates for the outturn.

All the factors which influence ready prices are anticipated by the speculators for determination of the future prices. But despite the existence of this speculative element in forecasting the future position of supply and demand, the future prices are found to be closely correlated with the ready prices.

X. *Factors Affecting Timber Market.*—Timber, like cloth, is one of those commodities which are articles of necessity as well as of luxury. Timber prices in this market are influenced by the following factors :—

(*i*) Supply and demand, as a general rule. Often sales are accelerated when the market is down.

There is little demand for timber during the monsoon period (July to September) when constructional works are at a standstill and labour is busy in agricultural activities.

(*ii*) Timber market responds to rise and fall in the grain market as well as to the general economic conditions.

Wheat being the main agricultural crop in this locality, sales are accelerated and timber market rises when this crop matures and enriches the pockets of zamindars and cultivators. Decrease in demand due to agricultural pre-occupations or rise in demand just after the agricultural crops are reaped, affect prices of chil and fir most, and deodar and kail to a small extent only.

(*iii*) Condition in other timber markets would naturally affect this market also.

Dated Bhuin (Kulu),
19*th February* 1935,

APPENDIX A.

Statement showing average of sale rates obtained at auctions in Doraha depot during 1934-35.

Round timber.

Species.	Quality class.	Average sale rate.	Remarks.
		per c.ft.	
		Rs. a. p.	
Deodar logs ..	I	1 6 0	
Do. ..	II	0 13 7	
Do. ..	III	0 7 4	
Grand total average deodar logs.		0 13 0	
Deodar Balla (over 12′) ..	Sm.	0 10 2	
Do. Do. (under 12′)..	,,	0 6 9	
Do. Balli (over 12′) ..	,,	0 9 2	
Do. Do. (under 12′)	,,	0 5 0	
Kail logs ..	I	0 12 6	
Do. ..	II	0 9 6	
Do ..	III	0 5 11	
Grand total average kail logs ..		0 9 5	
Kail Balla ..	Sm.	0 7 2	
Do. Balli ..	,,	0 6 11	
Chil logs ..	,,	0 8 4	
Fir ,, ..	,,	0 3 0	

Sawn timber.

Species.	Dimensions.	Quality class.	Average sale rate. Per scant.	Average sale rate. Per c.ft.	Remarks.
			Rs. a. p.	Rs. a. p.	
Deodar	*Gattus.—*				
	8′×12″ × 6″ ..	Sm.	5 6 11	1 5 9	
	6 × 12 × 6 ..	,,	3 7 4	1 2 5	
	4 × 12 × 6 ..	,,	2 6 5	1 3 3	
	Large sleepers.—				
	12 × 10 × 5 ..	Sm.	5 10 2	1 5 9	
	B. Gs.—				
	10 × 10 × 5 ..	R. R.	5 2 0	1 7 5	
	10 × 10 × 5 ..	A.	4 1 10	1 2 11	
	10 × 10 × 5 ..	B.	3 1 4	0 14 8	
	9 × 10 × 5 ..	R. R.	4 12 0	1 8 6	
	9 × 10 × 5 ..	A.	3 15 5	1 4 5	
	9 × 10 × 5 ..	B.	2 13 4	0 14 9	
	Small sleepers.—				
	8× 10 × 5 ..	Sm.	3 6 0	1 3 5	
	6 × 10 × 5 ..	,,	2 6 8	1 2 9	
	M. Gs. –				
	6 × 8 × 4½ ..	,,	1 15 0	1 4 8	
	N. G.—				
	5 × 7 × 4½ ..	,,	1 3 2	1 3 2	
	Other scants.—				
	12 × 8 × 5 ..	,,	4 3 9	1 4 2	

Species.	Dimensions.	Quality class.	Average sale rate. Per scant.	Per c.ft.	Remarks.
	Slabs—				
	9—10×10×3 ..	Sm.	1 15 10	1 0 0	
	Karries 12′ & over × 6″×6″ & over	,,	3 8 7	0 13 7	
	Karries 12′ & over × under 6″×6″	,,	2 4 11	1 1 6	
	Karries under 12′ × 6″×6″ & over	,,	2 12 6	0 15 6	
	Karries under 12′ × under 6″×6″	,,	2 1 9	1 4 10	
Kail.	*Gattu.—*				
	8′×12″×6″ ..	,,	4 8 2	1 2 0	
	6 × 12 × 6 ..	,,	2 10 11	0 14 10	
	4 × 12 × 6 ..	,,	2 0 9	1 0 5	
	Large sleepers.—				
	12 × 10 × 5 ..	,,	4 8 11	1 0 11	
	B. Gs.—				
	10 × 10 × 5 ..	,,	3 12 6	1 1 6	
	10 × 10 × 5 ..	R. R.	3 12 9	1 1 5	
	10 × 10 × 5 ..	A.	3 9 9	0 15 11	
	9 × 10 × 5 ..	Sm.	2 9 6	0 13 10	
	Small sleepers.—				
	8 ×10 × 5 ..	,,	2 15 0	1 0 11	
	6 × 10 × 5 ..	,,	2 3 0	1 0 7	
	M. Gs.—				
	6 × 8 × 4½ ..	,,	1 12 8	1 2 7	
	Scants.—				
	12 × 8 × 5 ..	,,	3 8 10	1 1 2	
	Slabs.—				
	9—10×10×3 ..	,,	1 10 5	0 13 2	
	Karries 12′ & over × 6″×6″ & over	,,	2 15 1	0 12 0	
	Karries 12′ & over × under 6″×6″	,,	1 11 2	0 12 9	

Species.	Dimensions.	Quality class.	Average sale rate. Per scant.			Average sale rate. Per c.ft.			Remarks.
	Karries under 12′ × 6″ × 6″ & over	Sm.	2	0	0	0	12	0	
	Karries under 12′ × under 6″ × 6″	,,	1	4	5	0	12	0	
Chil.	*Large sleepers.*—								
	12′ × 10″ × 5″ ..	,,	3	5	0	0	12	9	
	B. Gs. 10 × 10 × 5	,,	2	12	0	0	12	8	
	Small sleepers.—								
	8 × 10 × 5 ..	,,	0	11	6	0	4	4	
	6 × 10 × 5 ..	,,	0	7	0	0	3	6	
Fir.	*Gattus.*—								
	8′ × 12″ × 6″ ..	,,	2	14	3	0	11	7	
	Large sleepers.—								
	12 × 10 × 5 ..	,,	2	10	5	0	10	2	
	B. G's.—								
	10 × 10 × 5 ..	,,	2	0	0	0	9	5	
	10 × 10 × 5 ..	A.	2	5	2	0	10	9	
	9 × 10 × 5 ..	A.	1	13	0	0	8	1	
	Karries 12′ & over × 6″ × 6″ & over	Sm.	1	14	7	0	7	6	
	Karries 12′ & over × under 6″ × 6″	,,	1	5	8	0	9	0	
	Karries under 12′ × 6″ × 6″ & over	,,	1	7	1	0	7	6	
	Karries under 12′ × under 6″ × 6″	,,	0	12	6	0	7	6	

KHEM CHAND,
Extra Assistant Conservator of Forests.

REOPENING OF THE FOREST COLLEGE, DEHRA DUN

The following address was delivered by Mr. C. G. Trevor, C.I.E., Inspector-General of Forests, at the reopening ceremony of the Forest College, Dehra Dun, on 1st April 1935:

We are met this afternoon to mark the reopening of the Imperia Forest College.

The College has been closed for 2 years, as you probably all know, owing to the reduced demand for Forest Rangers on the part of provinces, due to the cessation of recruitment and to reduction in cadres on account of the universal slump which has affected the world during the past 3 years.

Now, owing to the generous assistance of the Governments of the United Provinces and Punjab which have provided the teaching staff free of cost to the Government of India and to the better support of the College by the provinces of British India and the Indian States, it has been possible to reopen with a class of 27 students which, under the circumstances of the case, is quite satisfactory.

I should like to take this opportunity of putting before you some of the facts in connection with the College of which you have now become members. The Imperial Forest College was the outcome of a memorandum dated 1st September 1877 by Sir Dietrich Brandis, the first Inspector-General of Forests to the Government of India, in which he urged on the Government of India the desirability of instituting a national forest school in India. Some of his remarks are most illuminating at the present day. He states that forestry must cease to be a foreign introduction, it must become naturalized before it can be regarded as built on a safe and permanent basis. The chief object of his proposed training school was to prepare students for the executive charge of a range and also to enable forest rangers to qualify for promotion to the superior staff.

To-day, 58 years later I, the seventeenth in succession to Sir Dietrich, have the satisfaction of telling you that the hopes of this great man, the founder of Indian forestry, have been largely fulfilled. All over

India the executive charge of ranges and even divisions is being held by past students of Dehra Dun or her daughter college at Coimbatore. Past students of this College have risen very high in the forest service of this country and have become the heads of the service in other parts of the British Empire. Without the loyal work of your predecessors the foundations of Indian forestry could not have been laid nor could Indian forestry have attained to the very high pinnacle which it now occupies in the world. It will interest you at this stage if I give you some account of the progress of forestry in India since that date—1877—which is very nearly 60 years ago.

The area under the control of the Forest Department has increased from 17,835 square miles in 1877 to 249,822 square miles or 22·7 per cent. of the whole area of British India and of this area 106.849 square miles are reserved forest permanently dedicated to the production of timber; all this area has been surveyed, demarcated, and 55·2 per cent. or 72.870 square miles of the area is under properly sanctioned working plans. During the first quinquennium 1869 70 to 1873-74—the revenue amounted to Rs. 56,30,061, the expenditure was Rs. 39,33,430 and the surplus Rs. 16.96,631. In the year 1932-33 in spite of worldwide depression the revenue was Rs. 3,74,11,020, the expenditure Rs. 2,87,96,552 and the surplus Rs. 84,14,408.

In 1877 there were 104 gazetted officers employed whereas to-day there are 591. In 1877 the crudest form of selection was the only management possible. To-day we have detailed yield and volume tables, we have accumulated much knowledge of the silvicultural requirements of individual species and elaborated where necessary detailed and intricate systems of management. The forests have been provided with a network of roads and fire lines, buildings have been constructed for the staff and a well-ordered property built up. But what of the other hope of Sir Dietrich that forestry must become naturalised before it can be built on a safe and permanent basis? I have travelled over the greater part of the world. I have had the honour to represent India in Canada, Australia and New Zealand. I have seen the forestry of all these countries and I can tell you that

the forestry we have developed in India (and by we I mean the professional brotherhood of foresters whether British or Indian) is the equal of that of any country in the world. All my life I have insisted on the development of a forestry technique to meet the needs of India and the conditions of Indian silviculture. We have devised silvicultural systems quite different from anything practised on the continent of Europe to meet our own particular needs. So much so that a very distinguished German forest officer after being taken round a certain division said to me "Mr. Trevor, I have travelled over the whole world and this is the first time I have seen something quite new." From the heights of the Himalayas to Cape Comorin examples of forestry may be seen second to none in the world. Most countries deal with a handful of species, we deal with every type of vegetation from tropical rain forest to temperate coniferous forest ; our work lies from the sandy desert of Sind to the borders of China, from Malabar to the mountains of Hazara. You who are sitting in front of me this afternoon, after your course here, will disperse all over this vast country, some of you will go to the desert, some of you to the hills, but wherever you go, the principles of forestry, which we shall try to teach you here, will persist. You may have to adapt those principles to your own particular needs but the principles will remain the same. It would not be right if I did not draw your attention to the very distinguished men who have presided over the destinies of this College, men whose names have often become known far beyond the limits of India, who have attained the highest scientific reward and who have left behind them a reputation of which any of us might be proud ; such men as Colonel Bailey, R.E., the first Director of the Forest School from 1878—1890: Mr. Gamble, F.R.S., who controlled the School from 1890—1899,—one of the great botanists of the age: Mr. Hobart Hampden, Mr. Lace and Mr. Perree—to mention only a few. The staff and myself will do our best to provide the best professional training at our command ; the resources of the Forest Research Institute, probably the biggest institution of its kind, are at your disposal. It will be for you to make the best of the opportunities which are given you : to work with intelligence ; to endeavour to acquire knowledge,

not by memorizing the text-book or your notes but by observing the world around you and the great works of nature which are spread out before your eyes. It has been said that the wilderness is the garden of God and what better life could a man lead than to be a humble worker in the garden of God ?

The forests of India are your heritage ; the control of this heritage will very soon pass entirely into Indian hands and it will be for you to determine whether you will continue to maintain this wonderful heritage or allow the forests of this country to revert to chaos and the garden of God to be destroyed. We, the British members of the Service, can, I think, look back on our lives and on the lives of the generations before us with some satisfaction ; we have turned a ruined estate into an ordered and well-managed property ; we have created order out of chaos ; and I do not think even the most ardent patriot can accuse us of not having served India well.

Politics have no place in forestry. I have devoted my life to the forests of India and can truly say that I shall leave them better than I found them. We, whether British or Indian, have as our only care the forests of India that we may order them and tend them and perpetuate them. Whether one power or another rules is not a concern of our profession ; we are bound together in a brotherhood devoted to the service of trees. If you store up this thought in your hearts, if you set out to master the secrets of nature locked up in the hearts of the trees of the forest, you will at the end look back with pleasure on your lives, you will live at peace with your neighbours and even if the material rewards of this world pass you by, you will have the greatest of all rewards—the knowledge that you have done your duty and served your country well.

And now I wish you success in life ; both during your studies here at the commencement of your career and when you will have left this place and gone your several ways into the forests of India and I trust that you will be able to look back on the time you have spent at Dehra as one of the happiest of your lives.

EXTRACTS

BROADCAST TALK ON FORESTRY DELIVERED ON 19TH NOVEMBER 1934.

The important timbers of Bengal, what they are used for and how they compare in quality and price with imported timber.

The reserved forests of Bengal belong to Government and are situated within the districts of Darjeeling, Jalpaiguri, Chittagong, Chittagong Hill Tracts, 24-Parganas and Khulna. They contain a bewildering mixture of over 500 different trees. I shall deal with each district in rotation.

2. The important timbers found in the hills of the Darjeeling district are Katus, Walnut, Panisaj, Toon, Champ, Birch and the Oaks. The scientific name of Katus is *Castanopsis hystrix*. It is a large tree occurring between 6,000 to 8,000 feet elevation. It is the best timber in the hills for structural work, such as flooring, walling and house-posts. The scientific name of Walnut is *Juglans regia*. It is a very large tree found from 3,000 to 10,000 feet elevation. It yields a decorative timber,—used a good deal for furniture and carving. Unfortunately the supply is very limited. At the Wembley Exhibition of 1924 the "King's Room" was panelled with carved Kashmir Walnut, and His Majesty the King presented a Kashmir carved screen of great beauty. Some of the finest furniture produced is faced with sliced veneers from Walnut burrs which have been exported to Europe, chiefly France, from Kashmir. The scientific name of Panisaj is *Terminalia myriocarpa*. This is also a very well-known species in Assam. It is called Hollock there. It is a very large tree found in the lower hill valleys of the Darjeeling district. The timber is very fashionable now-a-days for furniture, and has taken the place of the much scarcer Walnut. It is hoped that some of the panelling and furniture in the new Government House, Darjeeling, will be of Panisaj. It is really an all-round timber, being also used in structural work. If quarter sawn it is particularly ornamental, while in some pieces a wavy fiddle-back mottling is found. It makes up into a strong handsome 3-ply board. There are two factories in Assam which manufacture 3-ply tea-chests of Panisaj. I would recommend to anybody who wants good 3-ply wood for furniture or panelling to obtain their supplies from there. The addresses are :—

(1) The Assam Railways and Trading Company, Limited, Margherrita, Lakhimpur district, Assam ; and

(2) The Assam Saw Mills and Timber Company, Murkong Selek, Saduja Frontier Tract, Assam, North-East Frontier.

The scientific name of Toon is *Cedrela microcarpa.* The timber is primarily used for furniture, panels, ceilings and boxes. It is used a good deal in Madras for cigar boxes. It may be classed as a moderately ornamental timber. The scientific name of Champ is *Michelia excelsa.* It is a tall, straight, clean-boled tree, found at 6,000 to 8,000 feet elevation. Local demand absorbs what timber is available. It is an attractive high class timber with a beautifully straight grain and works to a smooth, glossy surface; it therefore polishes well. It is in great demand in Darjeeling for doors, window frames, panels, ceilings and furniture. The scientific name of Birch is *Betula alnoides.* This species has just come on the market since the Gramophone Company at Dum-Dum found it excellent for cabinet work. It polishes up beautifully and is excellent for all turnery work. My remarks on the Darjeeling species would be incomplete if I omitted the Oaks. They are known locally as Buk and Phalat. The scientific name is *Quercus.* They grow to very large trees from 100 to 120 feet in height and are most plentiful between 6,000 to 7,000 feet elevation. Considerable supplies are available. The timber is durable. It is an important building timber in Darjeeling; used for house-posts, beams, joists and rafters. It is also used in bridge construction and for firewood and charcoal.

3. The important timbers found in the Jalpaiguri district are Sal, Sissoo, Khair, Siris, Simul, Toon, Chickrassy, Champ and Pakkasaj. The scientific name of Sal is *Shorea robusta.* It is the most important timber in Bengal and used extensively in buildings and for sleepers. It is an extremely strong wood and the durability of the heart wood, even against white-ants, places it next to Pyinkado, as India's best sleeper wood. Pyinkado is a timber that comes from Burma. It is used a good deal in Calcutta and Chittagong. This is a serious loss to the Bengal Government, and attempts are now being made to induce the people to use Bengal Sal instead. The scientific name of Sissoo is *Dalbergia sissoo.* This, I consider, is one of the most beautiful timbers in India. It is much handsomer than either Teak, Mahogany or Padouk. It is in great demand wherever available. It makes most excellent furniture and beautiful panelling. It is hoped that some of the panelling and flooring in the new Government House, Darjeeling, will be of Sissoo. It also has its industrial uses. The Gun Carriage Factory at Jubbulpore use about 1,600 tons annually for ordnance work, such as gun carriage wheels. It is a very strong elastic timber, as strong as Teak and harder. It is also extremely durable and is one of the least susceptible Indian woods to white-ant attack. Due to the fact that it can be bent after steaming it is eminently suitable for bent-wood furniture and ordnance wheel felloes. The scientific name of Khair is *Acacia catechuoides.* This is the timber which yields the Cutch and Katha of commerce. The wood is very hard and durable and is not attacked by white-ants or fungus. In addition to being used for the manufacture of Cutch, it is also used throughout India, where available, for posts, parts of carts, pestles, sugar crushers and agricultural implements. The scientific name of Siris is *Albizzia.* There are three well-known varieties, *viz.*, Kokko, Black

Siris and White Siris. The largest supplies of Kokko come from the Andamans and Burma. It is sometimes known as "snuff-wood" on account of the irritation caused to the nose and throat when the wood is being sawn. This irritation is, however, only temporary and not injurious. Large supplies of White Siris are available in Bengal. It should be excellent for moderate-priced furniture. It is rather open-pored but, after grain-filling, takes an excellent polish. Some of the flooring in India House, London, is of Kokko. The scientific name of Simul is *Bombax malabaricum*—also known as the "Indian cotton tree." It is too well-known in India to need much description. It is used considerably in Calcutta for packing cases and crates, also for match boxes. It is durable under water where its chief enemies, fungi and borers, cannot attack it. If air-dried, it is apt to discolour. If freshly converted planks are placed in *clean* water for a month or so, and are then air-dried in open stacks, good clean boards can be obtained. Vertical stacking of freshly cut stock is also advantageous. The stacking can be done in the open air. The important point to remember is to dry the timber as quickly as possible after sawing. The demand for Simul has gone down a great deal recently owing to Japanese competition. You can buy Japan Pine in Calcutta almost as cheap as you can buy Simul, in spite of a 25 per cent. *ad valorem* import duty; because Japan Pine is a foreign article you cannot convince the Calcutta public that it is not a better wood than Bengal Simul; it comes in ship, etc., and they therefore think it must be better. The only remedy is to increase the import duty. A depreciated yen is a good deal responsible for this cheap Japan Pine. The scientific name of the Toon found in the Jalpaiguri district is *Cedrela toona*. I have already described the Toon found in the Darjeeling district; the same remarks more or less apply to the one found in the plains. There is more of the Plains kind available. It is probably the most commonly used furniture wood in India. It is cheap, light, easy to work and, if properly filled, takes a high polish. It seasons quickly and does not warp or crack under proper treatment. The scientific name of Chikrassy is *Chukrasia tabularis*. This, I would say, is our second handsomest panelling wood. It is also suitable for good class furniture. Burma exports it to England under the name "golden mahogany." I am certain the demand for it will increase to a surprising degree as soon as it becomes known. It is a lustrous wood with a beautiful satiny sheen. It finishes to a good surface and takes a high and lasting polish. Government House, Shillong, is panelled with Chikrassy veneer. I understand it is lasting well and is very much admired. The Allahabad Bank, Dehra Dun, and the drawing room of the President of the Forest Research Institute, Dehra Dun, are also panelled with this wood. The scientific name of the Champ found in the Jalpaiguri district is *Michelia champaca*. I have already described the hill variety as found in the Darjeeling district. There is very little difference between the two. Probably the plains variety is less inclined to warp and for that reason may be considered a better timber. There is good deal of it scattered all over the district. The demand is not as great as the supply. The scientific name of Pakkasaj is *Terminalia crinulata*. It is exported a good deal to London under the name of "laurel wood" for panelling and interior decorative work. The furniture in the Town Hall, Darjeeling, is of Pakkasaj wood. It is a difficult timber to air-season. Kiln

seasoning, on the other hand, gives excellent results and can be done quite easily. At the British Empire Exhibition at Wembley figured Laurel was noted as the most handsome of all the British Empire woods exhibited. If kiln-seasoned, there is little doubt that it is a wood of great value for high class panelling, cabinet and furniture work.

4. I shall next deal with the forests of the Sundarbans. These forests extend over the districts of Khulna and 24-Parganas. The trees there do not grow big and the value of the forests is not so much the value of the timber itself as because boats can get to almost any place and so the cost of carrying the timber to the markets is much reduced. The Sundarbans do not only supply timber and firewood, the sale of the leaves of the Gol Palm, which is used for thatching, is equally important. The principal timber species found are Sundri, Gengwa, Keora, Baen, Passur, Dhundal, Goran and Singra. Sundri (*Heritiera minor*) in the form of timber and poles is the most important marketable product from the Eastern Sundarbans forests. Owing to its great strength and durability it can be used in smaller sections than most timbers. Its principal uses are house-posts, beams, rafters, masts, oar handles and hull planking for boats Also owing to its toughness and elasticity the railways use it a good deal for tool handles and jute mills for picker-arms. It is close grained and therefore works well to a good finish Its other uses are firewood, hubs and axles of cart wheels, and ploughs. Gengwa (*Excæcaria agallocha*) is the next important marketable timber. This species owing to its lightness and the ease with which it can be cut, is used for cheap box-planking (for packing cases, etc.) and for match wood. It is also used extensively for dunnage in both large ocean-going craft and in small country boats taking out forest produce from the forests. The scientific name of Keora is *Sonneratia apetala*. The scientific name of Baen is *Avicennia officinalis*. Both are used for box-planking. The scientific name of Passur is *Carapa moluccensis*. It makes a durable house-post, and is also suitable for general construction work. The scientific name of Dhundal is *Carapa obovata*. This is a somewhat similar timber to Passur. It makes very durable house-posts. In Calcutta this timber is used for pen-handles. Actually, both Passur and Dhundal are much more durable than Sundri for house-posts. The scientific name of Goran is *Ceriops roxburghiana*. It has an extensive sale in Calcutta for fire-wood. Its bark is also used for tannin but not nearly so much as formerly. The Forest Department is now trying to get it used again for the latter purpose—samples have been sent to Europe for test. The scientific name of Singra is *Cynometra ramiflora*. This is the most popular fuel of the Sundarbans, and the best. It is utilised for this purpose in all sizes and shapes down to brush-wood.

5. The Chittagong Forests contain much valuable timber. The principal species are Teak, Gurjan, Jarul, Gamari, Tali, Pitraj and Chapalish. The scientific name of Teak is *Tectona grandis*. This species is so well known that I do not think it is necessary for me to say anything about it. The supply of Bengal Teak at the moment is only sufficient to meet local demand in Chittagong ; and it will be some years before there will be sufficient to compete against Burma Teak in the Calcutta market. The scientific name of Gurjan is *Dipterocarpus*. This species is used in

very large quantities by the railways for wagon floor boards. Burma and the Andamans are quite the biggest exporters of Gurjan to Calcutta. Unfortunately for Bengal 95 per cent. of the Gurjan that comes from those two places is sold in Calcutta under the name of "Jarul," the latter being a much better timber. Bengal persists, and quite rightly, in calling its Gurjan by the correct name and therefore not much of it can be sold until consumers of the alleged Jarul wake up to the fact that they are only getting Gurjan for their money. Bengal Gurjan is every bit as good as that of Burma or the Andamans. It can be obtained in squares up to 60 ft. long × 12″ × 12″. Gurjan squares of this size were supplied to the Burma Railways in connection with the construction of the big bridge over the "Irrawaddy" river completed last year. They cost about half what Douglas Fir would have cost and are much better. Gurjan is a very suitable timber for construction work, house building, flooring, staircases and roofing, but it is not white-ant proof. The Bank of England, London, and other important offices in London have been floored with this wood which is reputed to be silent to walk on. Part of India House, London, has also been floored with Gurjan. It should be thoroughly seasoned before being used. It air-seasons quickly and easily and gives little trouble. It is called "Hollong" in Assam. This Hollong is being manufactured into 3-ply wood for tea-chests and is quite satisfactory for that purposes. I can recommend it to anybody who wants cheap panelling for doors and almirahs, provided they do not use sizes bigger than 24″ × 24″. Gurjan creosoted under pressure has been found to be the most suitable of all species (including Teak) for use as piles and fenders where the teredo insect exists. This information should be of interest to Port authorities. Suitably treated Gurjan can perhaps be arranged if applications are addressed to the Forest Utilisation Officer, Bengal. The scientific name of Jarul is *Lagerstrœmia flos-reginœ*. It is called Pyinma in Burma and Ajhar in Assam ; if you want to buy pakka Jarul in Calcutta you must ask for Pyinma. It is a fairly common tree in Assam and Burma. There is not much of it in Bengal and what there is finds a ready market in Chittagong. The Forest Department is growing it extensively in plantations, and in years to come there will be any amount of it. It is a hard, durable, elastic, straight-grained timber and works to a clean finish. It has the dual advantage of being light and strong. It is very suitable for house building and constructional work, boat building, planking, scantlings, beams, posts, door and window frames, bridges, spokes of cart wheels, frames and shafts of carts, rice pounders, ploughs and well curbs. It is a species which should be encouraged for its valuable timber. The Forests of Jarul now being grown by the Forest Department in Bengal are a great potential asset to the Government. It has many advantages over Sal. As a matter of fact, the only advantage that Sal has over Jarul is that it is more white-ant proof. The scientific name of Gamari is *Gmelina arborea.* This is another very valuable all-round timber. Unfortunately like Jarul, the supply does not meet the demand. It is used a great deal in Chittagong for furniture making and is held next in importance to Teak for that purpose. It is a softish, light wood, can be worked fairly green and finishes to a smooth surface, taking polish or paint quite well. It is an extremely easy wood to air-season and having a low shrinkage figure is most suitable for general

work where lightness and strength are required. The scientific name of Tali is *Dichopsis polyantha*, and the scientific name of Pitraj is *Amoora rohituka*. These two species are much alike. They are used in Chittagong and East Bengal when people cannot get Jarul or when people want something cheaper than Jarul. Logs should be converted green and the sawn material open-stacked under cover to get the best results. This applies particularly to Pitraj. The timber is fairly durable and not much attacked by insects and fungi. It is easy to saw and work. The scientific name of Chapalish is *Artocarpus chaplasha*. It is moderately hard and easy to work, an excellent medium-weight wood suitable for interior work, furniture, turnery and carving, ornamental work and hulls of boats.

6. Generally speaking the price of all the timbers that I have been speaking about is much less than that of imported timbers, Teak is popular timber because it arrives seasoned from Burma and Siam and is white-ant proof. Such progress has been made at the Forest Research Institute, Dehra Dun, in experimenting with seasoning Indian timbers and treating them with antiseptics against insects and fungi that the demand for Bengal timbers is sure to increase. It has begun to do so already. Railways in the Punjab and Madras are obtaining large supplies of Sal, Sissoo, Siris, Kainjal, Chilaune, Bahera, and Parari from Bengal. No doubt they will season these timbers before using them. They will probably also apply an antiseptic such as creosote if they are going to use them in any place where there is a danger of insects or fungi. All timbers should be seasoned before being used and sapwood removed unless the sapwood can be treated with an antiseptic. By seasoning timber you increase its strength and durability, and prevent shrinkage, warping and splitting. It is a popular belief that timber can be seasoned in the log as quickly and as easily as it can in the form of planks and scantlings. This is not so, and the amount of seasoning which takes place in the log is negligible compared with the rapid drying which takes place in the case of sawn timber. If logs have to be stored before sawing the best and most practical way to do so is to store them under water. This prevents splitting and cracking and saves the logs from insects and fungus. But it must be remembered that water submersion is not a seasoning process although it makes subsequent drying of the wood after conversion more easy. I believe that logs stored under water are also easier to saw. The logs must of course be kept *completely submerged* otherwise the portions exposed to the air will dry out and crack. The Western India Match Company, Calcutta, Bombay, etc., always keep their logs stored under water. Of the thousands of logs stored in the log ponds of the Forest Research Institute, Dehra Dun, there has never been a single instance of a log having deteriorated during its period of submersion and some have been kept there for over two years. The value of a good log pond therefore cannot be over-emphasised; in the case of certain species, under-water storage is an absolute necessity. Logs of Pakkasaj and Chilaune, for example, if exposed to the sun split so badly after a few weeks' exposure as to render them quite useless. In the event of a log pond not being available, logs should always be provided with some sort of a shade or shelter. In addition they should be raised off the ground, bark removed and their ends painted with a waterproof paint or even coaltar.

7. The Forest Department in Bengal has made considerable progress during the 70 years of its existence. Sales perhaps have not received the attention they ought to have for want of staff, but still the net surplus has increased from Rs. 14,400 in 1865-66 to nearly Rs. 14 lakhs in 1929-30. For the last 3 years there has been a whole-time officer in charge of sales. Unfortunately the prevailing financial stringency has handicapped him in his efforts, but still new markets have been found in places as far away as the Punjab and Madras, and species that hitherto have not had a market have been sold. If Government could provide more money for roads, also for staff to supervise felling and extraction of timber, there is no doubt that it would pay, especially if a saw mill or two could be put in. Railways are the biggest purchasers of timber in India. Owing to the slump their purchases have dropped considerably. In 1927-28 they bought 282 lakhs of rupees of sleepers while in 1932-33 they bought only 127 lakhs of rupees. They also have to buy a lot of timber for their wagon and carriage workshops. In 1927-28 they bought 140 lakhs of rupees, while in 1932-33 they bought only Rs. 14 lakhs. India, in spite of its vast wealth of forests, is importing far more timber than it should. In 1933 the timber imports into India were valued at Rs. 32½ lakhs. Bengal is the chief offender in this respect, and I would suggest a policy of "*Buy Bengal timbers when they are as good as the ones you import.*" They are certainly far more beautiful.

T. M. COFFEY,
Forest Utilisation Officer,
Government of Bengal.

INDIAN FORESTER

JULY, 1935.

WOOD USED FOR BOWS.

In the year 1910 I was asked to supply yew wood for the Royal Company of Archers and the wood was duly supplied as requested from the forests of the Chamba State. Now after all these years the following information supplied by Mr. John Jamieson, Member of the King's Body Guard for Scotland, Royal Company of Archers, has come into my hands :—

" Some years ago, in 1910, through the kindness of Lieutenant-Col. J. Clayton Coldstream, I.A., I.C.S., now retired, who enlisted the kind help of the Indian Forest Service, a consignment of yew from the Himalayas was sent home to Archers' Hall in Edinburgh and after being seasoned for several years (I believe 5 years or more) was made up into Self-yew bows and proved a great success. The writer has two of them, first used in 1922, and they are still without "chrysalis" (cracks) or blemish and have proved admirable bows.

If there is any possibility of obtaining another consignment of yew, I feel sure that the shooting members of the Royal Company of Archers would welcome it and be grateful, as their bowmaker is very short of good yew, but of course the first cost and the shipping and other charges would have to be considered."

Mr. Jamieson has also supplied a lot of interesting information regarding the manufacture of bows in Britain.

Undoubtedly the best wood for bows is yew and it was probably the only wood used, homegrown in former times in Great Britain. A bow preserved at Archers' Hall in Edinburgh by the Royal Company of Archers and found in the field of Flodden, is of yew, in one piece, about 6′— 6″ long and estimated to have a pull or "weight" of 80—90 lbs. In the present day, bows are made in two pieces, an upper and lower limb, jointed under the grip.

Homegrown yew, *which will stand*, is difficult to obtain, *possibly* because of the moist atmosphere it is grown in, though the writer

has a Self-yew bow, *i.e.*, one piece of wood sapwood outside and heart inside—which is from 90—100 years old and has proved its worth, but not used now, by Winning Prizes at the 180 yards range. Its "weight" is (or was) 48 lbs. and it once belonged to the Earl of Cassilis. Many good bows were, and are, made of Spanish yew and Circassian yew.

Two reasons why bows are often made of other woods, usually hardwoods, are :—(*a*) the difficulty in getting good yew, and (*b*) the fact that yew being a soft wood will only as a bow give its full driving value, if the "quit" or "loose" (*i.e.*, release) of the string in shooting is sharp and clean.

Snakewood, beefwood, locustwood, fustic, washaba, most, if not all, South American woods, probably Brazilian, are used, but they are seldom one-piece bows in cross-section, being "backed" with hickory or even yew. The writer has a 3-piece 44-lb. bow of snakewood (belly), fustic, and hickory (back).

But all hardwood bows, while possibly less liable to break, are harsh in action and apt to jar the hand and arm when the string is released. Yew is the "sweetest" wood in "flexion and re-flexion."

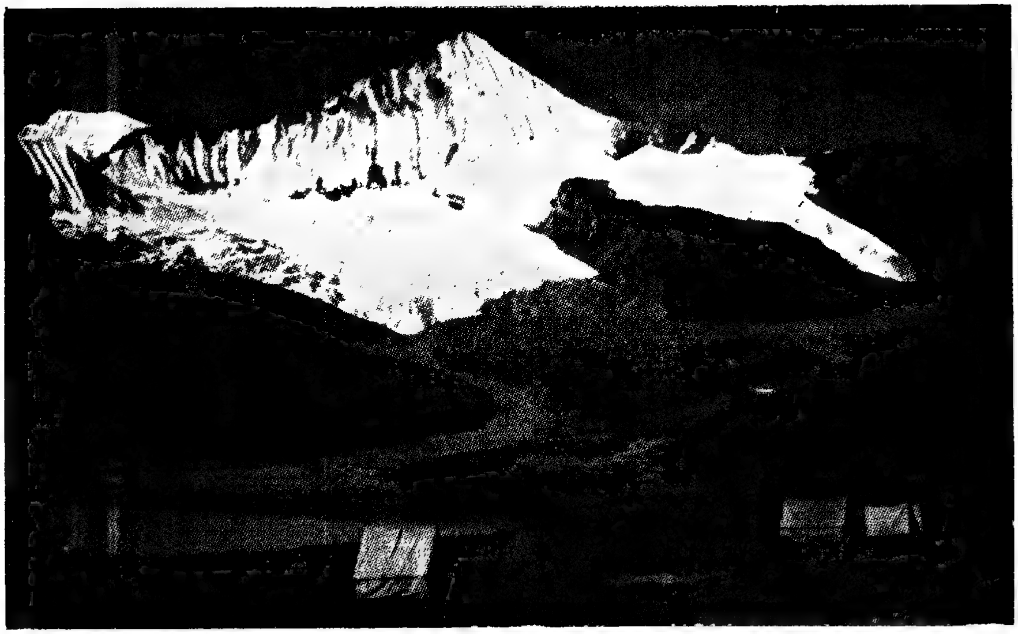
C. G. TREVOR.

AN EXPEDITION INTO SIKKIM.

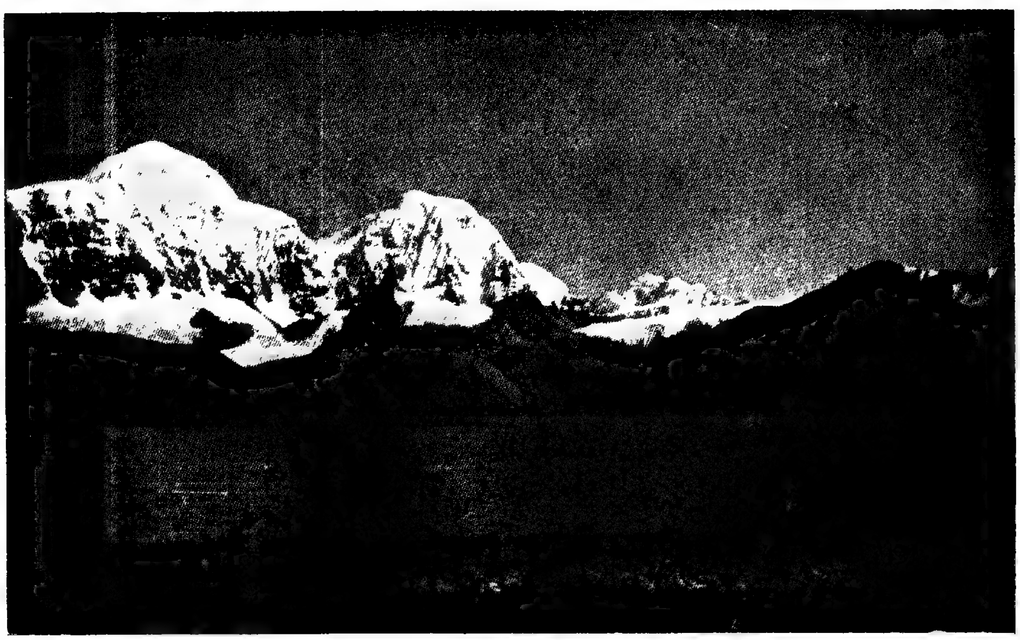
By F. C. Osmaston, I.F.S., Forest Research Officer, Bihar and Orissa.

Part I.

I have had a guilty conscience for about two years, but have not had the energy (or may I say the time?) to relieve myself of this incubus. At long last I am making the effort I should have made two years ago. In October 1932 I with three companions made an expedition into Lhonak, the north-west district of Sikkim. As soon as he heard I had been there, the Editor of the *Indian Forester* asked me to describe this event for the possible benefit of its readers. After pestering me with reminders for about a year he gave up the struggle in disgust. He will be as surprised as anyone (except myself) to see this contribution now.



Our base camp (17500′) at the foot of the Fluted Peak (19750′ about) "Glacier Camp" was at the top of the glacier towards the left and at the bottom of the steep 'fluted' part of the mountain.



A view across "Blue Lake" (about 17500′) looking north to the Koryade Range.

Mohila Press Ltd. Cal.

In 1932 I was persuaded by my cousin, Captain J. H. Osmaston, M.C., R.E., serving with the Survey of India, to cut short my home leave and join him in an expedition into Sikkim, with the main object of climbing to 20,000 feet. My heart failed me as I am no mountaineer. But his assurances that it would be merely a long walk persuaded me to go. In spite of the fact that much of the expedition was, in my opinion, not a mere walk but dangerous mountaineering, I shall never regret having gone to that beautiful country. In fact I should like to go again, and recommend others to do likewise.

Well, we were a party of four, namely, J. Latimer and A. B. Stobart from Calcutta and myself, under the leadership of my cousin. The expedition left Calcutta on the 1st October. But my boat was late and I only arrived in Calcutta on the 1st evening. Latimer and Stobart had, however, gone on ahead with all the stores and equipment, while my cousin waited for me to arrive which I did by the Imperial Mail at 11-30 P.M. My diary notes that I went to bed at 1-30 A. M., feeling tired. I was ; I can still remember how tired I felt.

On October 2nd we sorted out from my luggage my equipment and the equipment I had brought from England for the expedition and finally caught the Darjeeling Mail from Sealdah at 8-40 P.M. In the train we read off thermometer and aneroid readings as we meant to take these regularly throughout our trip. We were very keen mountaineers. We also took our pulse readings and I must say the daily readings of our pulses were quite interesting as we mounted higher and higher.

We arrived at Siliguri at 6-45 A.M. on the 3rd, and had a long day, as we had to catch up the rest of the party who were a day ahead. We piled ourselves and luggage into a Ford car and set off for Gangtok, the capital of Sikkim. We motored up the Tista valley, passing the frontier into Sikkim at Rangpo. Here we left the Tista to the west and progress was not so easy, as the road, though quite fairly good on the whole, was suffering from rain and we were twice held up by landslips that had to be cleared away before we could drive on. The main trouble of these delays was the loss of time. However, we safely arrived at Gangtok (5,800 feet) at 2-30 and found an excellent cold

lunch left behind for us by Latimer and Stobart. We were glad of it and did it full justice. We then loaded our effects on to 3 porters and on to ourselves (some 15 lbs. in rucsacs which seemed infernally heavy) and at 4-0 set off for our camp at Dikchu 13 miles away. We could motor $1\frac{1}{2}$ miles but the rest we had to walk, and a long way it seemed although mainly downhill. We saw little of the scenery as after going over the Penong La ("La" means a pass) it soon got dark. It also began to rain and my cousin developed a sore toe some 5 or 7 miles from Dikchu. We became convinced that Sikkim miles were longer than ordinary miles, and I did not lose my conviction of this throughout the trip. Nevertheless we arrived at last (9-0 P.M.) and were greeted by Stobart and Latimer in the excellent *dâk* bungalow at Dikchu (2,300 feet) and by a roaring fire and plenty of dinner. Our only regret was that we had just failed by 20 minutes to reach Dikchu within 24 hours from Calcutta. We got dry, removed leeches, filled our insides and tumbled into bed and were soon lulled to sleep by the Tista river roaring by a few hundred yards away.

The next four days were easy ones, with daily stages of 10—13 miles from bungalow to bungalow up the beautiful Tista valley. We were rising steadily all the time and these marches were of the greatest value in making us fit and getting us used to our rucsacs. We would rise at about 6-30 each morning and after as big a breakfast as our excellent appetites allowed, load up our 23 porters and 6 mules and walk away to the next halt, eating a sandwich lunch on the way. Views were not extensive as clouds enveloped all the hilltops, so that only steeply rising hillsides clothed with dense forest could be seen. Even so, it was all lovely and the foaming Tista was a never-wearying sight. The suspension bridges crossing the Tista and tributary streams also evoked our admiration as did the one or two bamboo suspension bridges. My cousin heroically crossed one at Dikchu (quite unnecessarily), the whole affair swaying up and down most perilously. I regret to say I had only enough courage to go about one quarter of the way over it.

Our sole trouble (besides my cousin's sore toe) was the leeches. These were a definite nuisance although not really bad and they

decreased in number after two or three marches. Otherwise it was a most lovely walk through grand scenery, and largely through forest. One could not help being struck by the grandeur, vastness and wildness of the land. Similarly, one was perpetually impressed by the constant struggle of the people to maintain a living. Precipitous hillsides and all invading forest wage war on all efforts at cultivation. Up to an elevation of 6,000 feet forests are dense. To compete against them, and the steepness of the mountain sides and concomitant landslides is a strenuous task. Above 6,000 feet the forests thin out to disappear at about 13,000 feet, but then the climate becomes cold and militates against any agricultural pursuit except the grazing of cattle and yaks. It is not therefore surprising that the population is poor and scanty. In fact in many places it is surprising that there is any population at all. But these observations really apply to all parts of the Himalayas, whose inhabitants throughout one cannot avoid admiring for their hardiness, tenacity against difficulties and misfortune, and their innate cheeriness in spite of (or is it because of?) all.

To return to my story. From Dikchu we marched 10 miles to Singhik (4,000 feet) where we halted the night, and on the next day (the 5th) marched 12 miles to Tsungtam (5,000 feet). For these 22 miles we had followed the Tista river, forests clothing the steep mountain sides to its edge, our path now rising to some hundreds of feet above it, now falling to run along its banks. The path was good for a hill road except where an occasional landslip had swept it away. It was some 4 feet to 8 feet wide, was paved roughly with stones on gradients, and possessed suspension bridges over the Tista and its larger tributaries and culverts over smaller streams. In fact, it is a good communication and trade route for pack animals or cooly transport, and can even boast of well kept milestones.

At Tsungtam the Tista bifurcates. One branch, the Lachung Chu, flows from the west or north-west. The other branch is the Lachen Chu which, continuing the main direction of the Tista, flows from the north. It was the Lachen Chu that we followed from Tsungtam on the 6th, marching 13 miles and rising 3,600 feet to Lachen.

This was a wet walk as a beautiful morning was spoilt at mid-day by a drizzle that developed into steady rain and then into a cold and heavy downpour. This hurried our paces, especially mine, as I was still in shorts, while a sweater and as fast a walk as I could manage failed to keep me warm. So the Lachen bungalow and a roaring fire was a welcome haven.

Lachen (8,600 feet) is a big village boasting not only of a Monastery but a Christian Mission in the charge of a charming Finnish lady Miss Konquist. The next morning, before beginning our 13-mile walk to Thangu, we all visited the Monastery. The priests were away but a choukidar (or his equivalent) let us in and we examined it with interest and took photos. It was the first Buddhist Monastery I had ever seen and so I was particularly interested in the gongs at the door, the rows of manuscript books and pictures round the walls and the Buddha images.

Our march to Thangu was the hardest we had yet had. It again began to rain at mid-day, but this time we had kept out our waterproof coats and at least kept dry and warm. But it was a long rise, 4,000 feet in the 13 miles, and by the time we reached Thangu (12,500 feet) we had all begun to feel the altitude. We were all rather exhausted, but tea, a fire and a grand hot bath soon put us right again so that we were well able to sort out kit, examine our climbing boots, take reading from our boiling point thermometers and aneroids, write up our diaries and the like.

Though tiring, it had been an interesting march. The more or less tropical forests below Tsungtam had the day before given place to temperate oak and coniferous forest, and from Lachen to Thangu these had thinned out still more to coniferous and rhododendron forest while open grassland was becoming common. Moreover, I was most interested to have my first sight of a yak—an animal I have always wanted to see since a boy when I was read some "nonsense" book of animals that attributed every possible pernicious character to the yak. A primary school at the small graziers' village of Yongga was also interesting, as it was somehow hard to believe that schools could find a place in this wild part of the world.

On the 8th October our real expedition began. So far we had lived luxuriously in *dak* bungalows. Henceforward we were to leave habitation behind and live in our tents. We awoke to a fine sunny morning at 6-30 and we were feeling the altitude but only slightly. My diary records : "A pretty good night, waking only once or twice. Good appetite for breakfast at 7-45 A.M. Very slight headache. The others not quite so well, Stobart not being hungry, Latimer having been sick and Gordon (my cousin) nearly as well as me."

Before setting off for our camp at Pogi (only 5 miles away but 2,000 feet higher than Thangu), we reorganised our transport. Our six mules were paid off and six extra porters engaged temporarily. These men would be sent back after three or four days when we reached our base camp wherever it might be. They were engaged mainly to bring fresh provisions such as potatoes and apples (very good apples could be had all the way up the Tista and Lachen Chu). We also bought two live sheep which joined our party quite fairly willingly not knowing that early death and transformation into mutton awaited them. All this organisation meant rearrangement of our porters' loads. But it was a fine, fresh, sunny morning and we left cheerily enough at 9-0 A.M.

We could see our camping ground ahead (more or less due west as we now left the Lachen Chu), lying under the Lungnak La, a pass of about 17,000 feet lying covered with snow between rocky peaks on either side. The path soon became a rough, narrow track or cattle path only. Forests disappeared, their place being taken by dwarf rhododendron, stunted juniper and grass. Gentians too we found, their lovely blue decorating the damp grassland near streams. But generally speaking the hillsides were a reddish brown from the stunted juniper and rhododendron

We reached Pogi (14,300 feet by aneroid) and pitched our camp below the snow line at mid-day in a fairly flat and sheltered though damp spot. But soon after our lunch it began to sleet and snow, the beautiful morning being spoilt by clouds that rolled up the valley after us. We distributed warm clothes and boots to our porters and

after a high tea settled down in our Meade tents for the night, feeling we had at last started the interesting part of our trip.

The next morning we moved on over the Lungnak La to Mukatang camp in Lhonak, the name given to the high plateau in N.-W. Sikkim, that borders on Nepal to the west and Tibet to the north. Mukatang is only about 14,500 feet and 11 miles from Pogi, but it was a hard day as we had to climb over the La (1,700 feet) and we were not yet acclimatised. I think my diary will describe this day's march better than my memory and I quote from it almost verbatim :—

"Up about 6-15. Gordon felt a bit sick and was sick. He dressed first as there is only room in a tent for one to dress at a time. In the next tent Stobart was also feeling sick. Latimer and I all right except for a slight headache and not quite such good appetites as heretofore. The porters got off from 8-0 to 8-30, Gordon and I leaving at about 8-20, the others a quarter of an hour ahead. We were walking in melting snow, as there was 1 to 1½ inches of snow from the fall during the night, along a path very steep and rough, over loose rocks. My rucsac was heavier than usual as I had put more warm kit in it. It was hot walking in the sun, but clouds, coming up the valley faster than we were, soon obscured the fine view of Kanchenjou and Thangu (?) peaks behind us. We saw tracks of two snow leopards in the snow at 1,500 feet.

We reached the pass at 11-15 in a straggling line in a thick mist and a cold wind, some snow falling. Some of us missed the track, but in the end we all found our way over thankfully, and started down the steep drop to Chabru Lake which emerged into sight out of the clouds 15 minutes later. The snow was deeper on this side (about 6 inches) and binding. It was quite slippery and I fell twice but kept up a fair speed. As we neared the lake and left snow behind us a lovely view opened out down the valley across to Langpo, Jongsong and Pyramid peaks.

I stopped at the lake for lunch, Latimer going on. Gordon and Stobart arrived after 15 minutes, too done up to eat. Gordon sick.

We waited another 15 minutes while I ate hungrily, then went on. I went on fairly fast down the valley and got to Mukatang first at 2-0 P.M. Latimer who had gone to sleep on the way arrived 10 minutes later, when most of the porters arrived too. "We decided to camp here as Gordon and Stobart were so exhausted. Besides it is a nice, dry, sunny place, most luxurious compared to Pogi. We put up the tents and got camp ready. Gordon and Stobart arrived some 40 minutes later when we had tea ready. Both feeling sick and unable to eat or even drink tea. Brandy helped them a bit. Latimer and I were pretty fit, I the fitter I think as I have a good appetite and not much headache. But I felt exhausted going over the pass."

This account (perhaps rather crudely) shows how we were getting acclimatised, I probably felt the altitude least because I was just out from England while the others had spent all the hot weather in Calcutta and their blood was probably thinner than mine. But as this account will show, we all had our bad days. My cousin got fitter and fitter, and I towards the end seemed to get worse and worse, while Latimer had trouble too.

The next two days we continued westwards along the Lhonak plateau or large valley between mountain ranges. Extracts from my diary will again, I think, describe what we did better than writing from memory.

"*October 10th, Mukatang to Chirap Camp* (1,500 feet).

A grand day. Up at 6-15 to a lovely morning though mist hid Kanchenjanga's peaks. After a good breakfast (for me anyhow) we were away at 8-15. We stopped after a mile or so on a saddle overlooking Tebri, a large open and flat grazing ground. Gordon took plane table sights on to the main peaks, such as Kanchenjanga, Tent and Pyramid peaks which rose grandly clear against the deep blue sky 25 miles away. After taking photos we swung down to Tebru where Gordon and I took photos and measurements of an old stone building which we surmised were the lower walls of a grazier's hut on to which probably a temporary canvas or other roof is fixed. There are, of course, no graziers here now as they only come up during the hot weather and rains.

Then we went on up the sloping valley fording the Zemu Chu, which here flows from the north, to follow the easterly flowing Lambu Chu, whose steep banks flattened out when nearing our camp at Chirap. We arrived there at 1-30 or 2-0 P.M. and after some tea and food admired the grandeur of Langpo, Jongsong and Lhonak peaks just visible to the west. Below Jongsong and 7 miles away stood the narrow ridged Fluted Peak (20,500 feet according to the map) which we think we shall try to climb.

Latimer and I then decided to make a small climb of 20 minutes to a saddle behind us, for the view. We started at 3-0 and got there at 4-0 ! Hard going over rocks, but we both felt well. There was a gorgeous view to the south-west. We were about 16,000 feet high and spread before us were Kanchenjanga, Tent and Pyramid Peaks, Langpo, Jongsong, the Fluted Peak and part of Lhonak Peak. Only Kanchenjanga and Tent Peak were partly hidden by cloud. This wonderful panorama more than repaid us for our climb, though to the north-east we could see nothing owing to clouds. We came down fast in 25 minutes.

So we are now well into Lhonak. What strikes one immediately is the dryness and absence of snow. The rains from Bengal flood into Sikkim, storming the mountains and their passes but waste away into mere wisps of thin cloud on reaching Lhonak. So the hills are rocky and dry, dusty and covered with a little coarse grass, moss, lichens and some dwarf juniper, while gentians cover the grazing slopes when not too far from water. For life there are marmots, ravens, chuffs, some kind of hare (I saw droppings) and a smaller finch-like bird, while Stobart said he saw a snipe to-day.
A cold, dry, stern, life-denying but grand country.

I and Latimer are in excellent health this evening, full of beans with little or no headache. Both Gordon and Stobart are better and equal to a good dinner."

It is interesting perhaps here to record that the air temperature outside our tents at Chirap was 33° F. at 5-30 P.M., which dropped to a minimum of 15° F. that night. Our boiling point thermometers

(boiled in tea) gave an altitude of 14,865 feet and our aneroids a reading of 14,825 feet. The rate of my pulse was 86 when lying down compared to 70 when sitting in Calcutta. Later on when at 18,500 feet my pulse, when reclining, was 92.

The next day we moved on to a temporary base camp 7 miles further west up the Lambu Chu. It was an easy march, though I was not so fresh as the day before, and the only event of importance was transporting our two sheep across the Lambu Chu. It was a narrow crossing that one could jump but the water was flowing very fast and the take-off side was difficult. The sheep did not enjoy the proceedings of being half hoisted and half thrown across nearly as much as we did. But though otherwise eventless the views were as usual marvellous. The Fluted Peak was now immediately south of us and in the afternoon we made our first reconnaissance of its approaches. Incidentally, I walked on the first glacier I had ever trod. It did not fulfil my expectations of what a glacier should be —clean and hard, with occasional deep chasms or crevasses, cruel and hungry. So I was disappointed at its extreme dirtiness and conglomeration of débris at its snout. I was also surprised at its jumbled, broken structure, and depressed at the knowledge that I should have to negotiate considerable lengths of this or another glacier. Obviously progress over any glacier would be definitely more laborious than I had hopefully expected, while the moraine along a glacier's edge was nearly as formidable. In fact I was filled with misgivings at my ability even to begin climbing this Fluted Peak whose approaches looked full of danger, if not impossible to scale. The others were more hopeful though less optimistic of its being a " walk-up " than the day before when the rocky arrètes or ridges looked less difficult from the distance. In fact I was rather depressed as well as tired when we returned from our reconnaissance, largely because my left knee was paining me considerably.

But what gorgeous country we were in. Miles from anywhere in a wonderful setting. We were on the borderland of forbidden Nepal and Tibet. We were 16,000 feet high and yet the mountains

towering above us made us feel we were in a low-lying valley. The Dodang-Nyima Peaks and Range (some 22,000 feet high) rose majestically above us to the south, their feet resting on the very morraine on which we were camped. And this chain of mountains was all around us except to the immediate east whence we had come. We were in a dry spot, comfortably camped, free from snow and ice; bare and inhospitable it is true, but all around was glistening snow relieved by glaciers and rocks. We had not done (and would not do) anything wonderful, but we were in a place where one could understand the adventures and trials, resource and hardiness of explorers of whose accomplishments we had read, wondered at and admired. It was well worth coming.

The next day (the 12th October) was a day of rest for the porters, a day of partial rest and reconnaissance for us. Part of the day we spent in further examination of the approaches to the Fluted Peak, and in finally deciding we should have to attack it from another point, more to the south-east. The Peak is approached by three steep ridges or arrètes. The ones from the north and west (which joins it to Langpo Peak) are covered largely with snow and ice. To climb them would probably require two days' work which would entail difficult camps on the arrètes. The western ridge being a rocky one could perhaps be climbed in a day, necessitating only one camp at the head of the main Fluted Peak glacier. Having decided this, we sent back porters to Thangu for some stores we had left there. They would return in 5 or 6 days. We also examined our alpine climbing rope, practised making knots, ovehauled our boots, and also but not least my cousin continued taking survey data as we were trying to test the accuracy of the existing maps, which were far from accurate in many particulars. We also all washed ourselves as well as we could in basins out in the warm sun, and aired our bedding. Our sleeping bags all got surprisingly moist due to their waterproof coverings. Body moisture goes through the inner layers to be stopped by the coverings, and then incidentally, to freeze each night in the form of hoar frost.

(To be continued.)

METHODS OF RAPID DETERMINATION OF MOISTURE CONTENT OF WOOD.

By S. N. Kapur and D. Narayanamurti, Seasoning Section, Forest Research Institute, Dehra Dun.

The usual method of determining the moisture content of wood by drying a small sample in an oven at about 100° to 105° C., till constant weight is attained, has the drawback that the process requires considerable time to carry out. Even when the sample is in the form of shavings or thin chips, a period of about 8 hours is necessary, and with the usual cross-sections obtained from planks and scantlings, drying has to be continued in the oven for a period of not less than 24 hours. There are many occasions when it is necessary to find out the moisture content of a piece of wood without any appreciable delay. For instance, during the process of kiln-drying, it is not uncommon that the sample boards, which are weighed at intervals for determining the progress of drying of a kiln-charge, give faulty results, on account of the difficulty of securing average representative material for the samples; and before making any change in the conditions of drying, or at the time of unloading the kiln-charge, it is imperative to know the actual moisture content of pieces of wood in the different parts of the charge. Again the method of oven-drying has another drawback, namely, the wastage of wood caused by cutting out samples for test purposes. Lastly, this method, although giving reliable results in the laboratory with all woods except those containing appreciable quantities of volatile constituents, is not adaptable for field purposes. With improvised drying ovens fitted with electric light bulbs or kerosene oil stoves, the drying is either imperfect, or over-done, and the moisture content values obtained with such ovens are seldom very reliable.

During the last few years, various workers have been engaged in investigating methods of moisture determination, with a view to finding out a method which is rapid, reasonably accurate, convenient, and which avoids any wastage of wood. The incentive for this research was first given in the United States of America by the

National Lumber Manufacturers Association, who in 1927 announced a prize for an apparatus for the rapid determination of the moisture content of wood. The result is that at present there is a variety of moisture meters available in the market, some of which, within limits, are fairly satisfactory and reliable.

1. HUMIDITY METHOD.

The first principle to be made use of for the rapid determination of moisture content of wood was the relation between the moisture contained in wood and its vapour pressure. M. E. Dunlap of the Forest Products Laboratory, Madison, U.S.A., built a form of hygrometer, with a bulb made of goldbeater's skin attached to a capillary glass-stem which was filled with mercury. If the bulb was placed in a freshly bored hole in a piece of wood to be tested, it expanded or contracted according to the moisture content of the sample, which was indicated on the stem by the rise or fall of the mercury column. The instrument did not, however, prove to be a success on account of the difficulty of standardizing it, and its liability to get out of order.

The humidity method of measuring moisture content has, however, found successful application in another sphere, namely, for determining and controlling the moisture content of paper at the dry end of the paper machine. A rayon ribbon is generally employed, which is placed in close proximity to the paper surface, and its expansion or contraction is measured by means of delicate instruments. Heppenstall and Hauff (*Paper Trade Journal, Tappi Section*, **96**, 1933, 265) refer to various kinds of circuits with vacuum tubes and condensers with the help of which slight movements of the rayon ribbon are sufficiently magnified to operate relays and control steam to the driers, thus making the operation automatic.

A very simple kind of instrument on this principle is described by Pfeiffer (Chemische Fabrik, **6**, 1933, 406). It consists of a small container for the material to be tested, the lid of which has on the underside a very sensitive strand of hair, and a pointer with a scale on the outside. The scale can be made to read directly in moisture percentage after previous calibration with known standards. It is

stated that the moisture content of a board of wood can be determined by placing the lid of this instrument directly on the board, and allowing a few minutes for equilibrium to be attained. Within the ordinary atmospheric range, the readings are not affected appreciably by variations in temperature, but if the moisture distribution is irregular, the results obviously cannot be relied on.

2. Distillation Method.

Basically this method is similar to the oven-drying method, with the difference that the evaporated moisture is condensed and collected in a measuring tube. The liquid most generally employed for distillation is xylol (Boiling Point, 140° C.) and the results obtained with non-resinous woods are nearly as accurate as those obtained by the oven-drying method. In the case of woods containing volatile substances, such as deodar (*Cedrus deodara*), this method gives more reliable and accurate results than the oven-drying method. This point has been discussed in detail by the authors in another article to be published shortly in the *Empire Forestry Journal*. Compared with the oven-drying method, it is more rapid, requiring about 1 to $1\frac{1}{2}$ hours for an average determination. Recently various kinds of improved distillation apparatuses have been suggested, employing the principle of reflux-distillation, which shortens the time considerably. One such apparatus, devised by Pritzker and Jungkunz (*Chem. Zeitung*, **53**, 1929, 603), has been tested by the authors and found satisfactory. With the exception of reduction in the time required for a moisture determination, the drawbacks with this method are again the same as with the oven-drying method, namely, the wastage of wood in obtaining samples for test, and the difficulty of adapting it for field-work. Even for routine laboratory work, the distillation method is rather cumbersome.

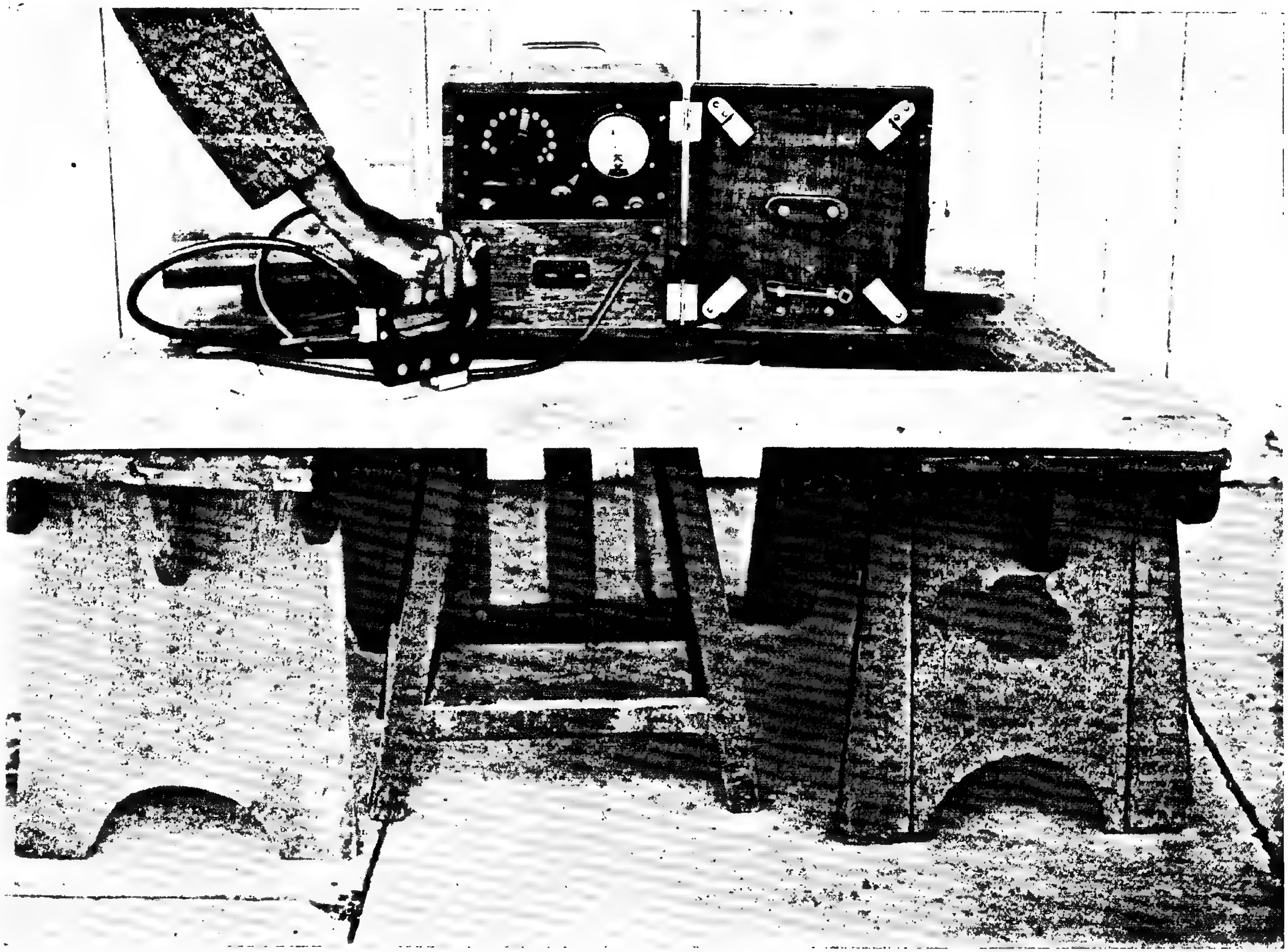
3. Electric Resistance Method.

The earliest investigation into the electric resistance of wood was carried out by Jujiro Hiruma (*Bull. Forest Exp. Station, Meguro, Tokyo*, 1915, 59-65), who showed that the resistance decreased with an increase of the moisture content in wood. Hasselblatt (*Zeit. Anorg.*

Allgem. Chem. **154**, 1926, 375) experimenting with birch found that the logarithm of the electrical resistance decreased in direct proportion to the increase of moisture up to about the fibre saturation point, above which there was, however, very little change in the resistance with increased moisture content. Myer and Rees (*Syracuse Univer. Tech. Bull.* No. 19, 1926) investigated the electrical resistance of wood with special reference to the fibre saturation point, and found that during the process of drying the resistance of wood remained practically constant till the fibre saturation point, beyond which it increased rapidly.

A detailed study of the electric resistance of wood as a measure of its moisture content was made by Stamm (*Jour. Ind. Eng. Chem.* **19**, 1927, 1021), who used a Megger insulation tester for the measurements. By this means he found that the moisture content of a piece of wood having fairly uniform moisture distribution could be determined to within about one per cent. of the absolute moisture content. The effect of species, density of the wood, direction of flow of current through the wood, ash content within reasonable limits, and the extent of specimen beyond the electrode surface, was either negligible as compared with the enormous effect of a change in moisture content or could be corrected in most cases. The method was found suitable for thoroughly seasoned wood, with a uniform distribution of moisture. Stamm later designed an apparatus with a pin type of contacts (*Jour. Ind. Eng. Chem., Analyt. Ed.*, **2**, 1930, 240) for measuring electrical conductivity of wood, which gave the average moisture content even when the distribution of moisture in the piece was irregular on account of any normal drying gradient. Stamm tested specimens of wood of 25 species, and found that the mean deviation from the average straight line was 0·6 per cent. absolute moisture content, and the maximum deviation 1·7 per cent. absolute moisture content. He discovered no appreciable variation among the various woods tested, and no consistent variations with change of density within a given species.

The electric resistance of wood is of a very high order, and, particularly at low moisture contents, wood is a good insulator.



Moisture Content of a Plank of Wood being determined by the Tag-Heppenstall Moisture Meter.

Suit and Dunlap (*General Electric Review*, Dec. 1931, 706) found for Douglas fir a resistance of 25,000 megohms at 7 per cent. moisture content, which dropped to 0·35 megohm at 26 per cent. moisture content. The change, therefore, from 7 per cent. moisture content to about the fibre saturation point is about 70,000 times.

There are various methods of measuring high electric resistances and it would be out of place here to go into details of the circuits described in the literature. The usual method of measuring very high resistances involves the use of a ballistic galvanometer, which has numerous disadvantages. A slight variation in the characteristics of any part of the apparatus, or a slight variation in the technique, serves to introduce errors into any result obtained with this method. A few preliminary experiments with this method were carried out by the authors, which showed that the method can at best be used in the laboratory and even then considerable care is required to obtain satisfactory results. Wheatstone bridge is more suitable for the purpose, in that it is a null method, but for the measurement of high resistances, the ratio of the two resistance arms of the bridge becomes very high near the limit of the range of operation, with a resultant loss in accuracy. A modification of this method by Clark and Williams (*Jour. Phys. Chem.*, **37**, 1933, 119), employing a Compton electrometer in place of the usual galvanometer, and two variable voltages in place of two variable resistances has given very accurate results with wood, bakelite and other insulating substances.

With the advent of the electrometer triode, the measurement of high resistances has become much easier, and several different kinds of circuits for the purpose are described in current scientific literature. With the help of these radio valves, it is possible to amplify considerably minute currents and voltages so that their measurement becomes a comparatively easy matter. T. E. Heppenstall of the Longbell Lumber Co., Longview, Washington, U. S. A., was the first to make use of this method of current amplification in an instrument for the rapid determination of moisture content of wood, which he brought out in 1927, and which is known as the Tag-Heppenstall

moisture meter. Since then a number of types of electric moisture meters on the electric resistance method have been put on the market, a few of which will be described below :—

I. The Tag-Heppenstall Moisture Meter.—This is a compact, portable instrument, which is easy to work, and within the moisture content range of 7 per cent. to 24 per cent. gives fairly accurate and reliable results. At the end of a long flexible cable there is a wooden handle having 2 pairs of gramophone needles, which by a short hard blow of the handle are driven into the sample of wood to be tested. The needles penetrate to a depth of about ¼ inch, and when the switch on the instrument is turned on, a current from a battery of dry cells of about 90 volts passes between the needle points. The current, which is naturally very feeble, is greatly amplified by means of a radio valve circuit, and is then balanced against the current from another battery of dry cells by means of a variable resistance. The resistance is regulated by means of a dial switch, till the balance is attained which is shown by an ammeter. A simplified circuit diagram of this instrument is given in Figure 1 (Plate 27). The dial is marked in moisture contents, and at the point of balance, the moisture content of the piece to be tested is read off directly from the position of the switch on the dial.

The instrument can also be used for sorting out pieces of wood below and above a given moisture content. For instance, when the dial switch is set at 10 per cent., and the needles are driven into a plank of wood, if the moisture content of the plank at ¼ inch depth is above 10 per cent., a small green light located in the handle will glow. If the moisture content is 10 per cent. or lower, there will be no glow of the lamp.

A meter of this kind has been in use at the Forest Research Institute, Dehra Dun, for a number of years, and although it gave some trouble when one of the resistances got accidentally broken, on the whole it has given very satisfactory service. It has been used for determining the moisture distribution in boards and scantlings of various indigenous hardwood species during the course of kiln-drying, and the results have always been found to be approximately correct.

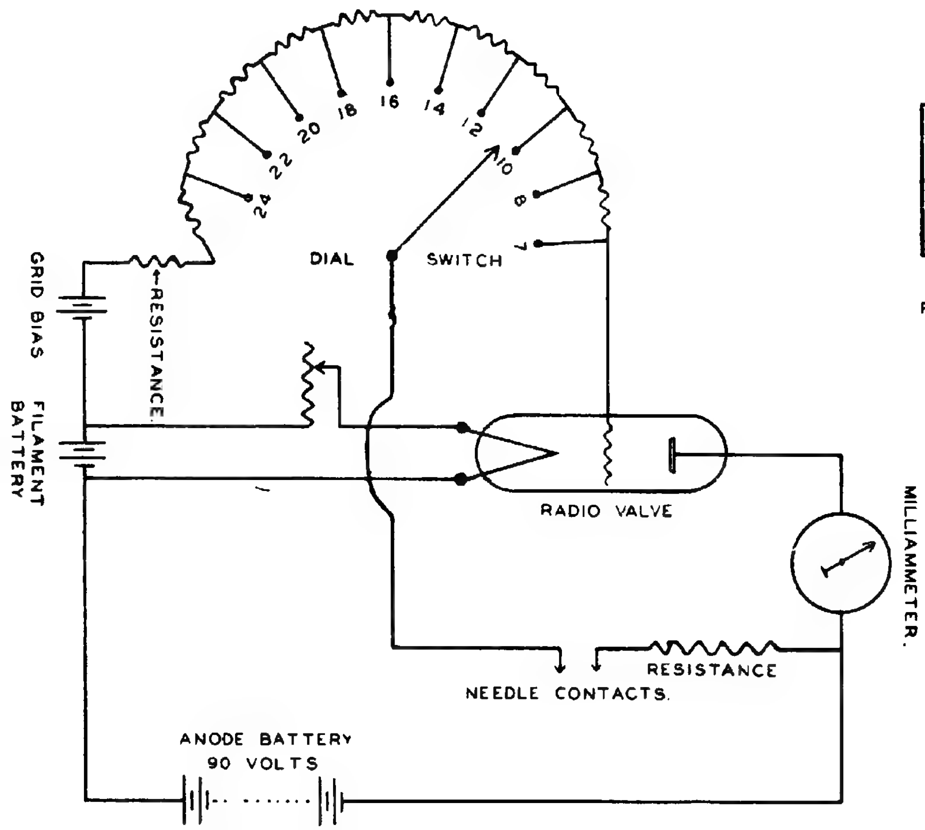


FIG 3 CIRCUIT DIAGRAM FOR TAG-HEPPENSTALL MOISTURE METER.

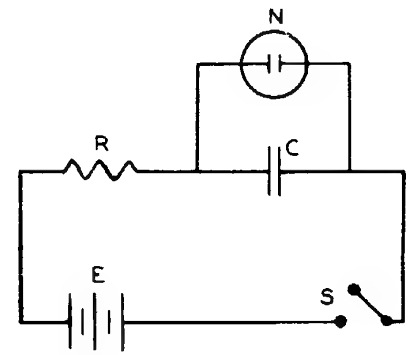


FIG. I NEON-TUBE OSCILLATOR CIRCUIT

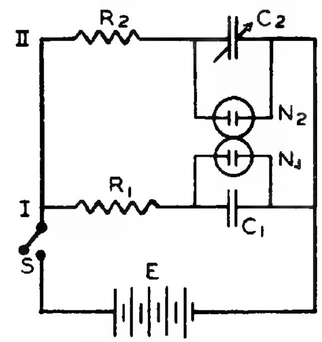


FIG 2. CIRCUIT ARRANGEMENT FOR "BLINKER" MOISTURE METER

In the case of thick scantlings, it has been found practicable to drive steel nails to various depths in the wood, and connect the needle points to the heads of the nails. The distance between the nails is kept the same as between the pair of needle electrodes. This can be managed either by means of a template, or by driving the needle electrodes into the wood to be tested, the holes left by them serving as guides for driving the nails. By this arrangement it has been possible to determine the moisture content of broad-gauge sleepers of coniferous species at various depths, in order to determine the progress of drying during an experiment on the air-seasoning of softwood sleepers.

With regard to the effect of species, the correction table supplied by the makers with the instrument for common woods available in America indicates that the amount of error varies with the moisture content. Except in the case of elm and South African mahogany, the correction is within +2·0 per cent. absolute moisture content. In the case of elm at 20 per cent. moisture content, the correction is – 4·0 per cent. and for South African mahogany at the same moisture content +3·5 per cent. on the meter readings.

Experiments carried out with Indian timbers have shown that within a range of 8 per cent. to 20 per cent. moisture content, the correction to be applied to the meter readings is within the same limits as indicated by the makers for common woods available in America, except in the case of teak, which has given rather erratic results and is being investigated further. The following table gives the approximate corrections for different moisture content ranges for some of the more common Indian woods :—

Wood.	..	Correction to be applied to instrument readings according to sign at moisture content. 8%	10%	12%	14%	16%	18%	20%
Chir (*Pinus longifolia*) ..	..	..	0	—1	—2	—1	0	..
Walnut (*Juglans regia*) ..	..	..	0	—1	—2	—2	—2	—1
Haldu (*Adina cordifolia*)..	..	..	0	0	—1	—2	—2	—1
Sissoo (*Dalbergia sissoo*) ..	..	+1	+1	+2	+1	0	..	..
Rosewood (*Dalbergia latifolia*)	..	..	0	—1	—2	—2	—2	..
Toon (*Cedrela toona*) ..	..	..	0	+1	+1	+2	+2	+3
Andaman padauk (*Pterocarpus dalbergioides*) ..	..	..	—1	—2	—2	—2	..	..

Further tests are in progress, and it is hoped to have a more complete table ready shortly.

There is a temperature correction for the instrument as well, when the electrodes are driven into wood at too high or too low temperatures, but it is always preferable to allow the samples to attain the ordinary room temperature, 70° to 90° F., before testing.

When the surface of wood is wetter than the interior, the meter cannot be expected to give correct results. In an experiment on air-seasoning softwood sleepers, some of the sleepers had become wet on the surface on account of a rainfall, and in order to avoid the electrodes coming in contact with the wet surface layers, $\frac{1}{4}$ inch holes were bored in the wood to a depth of about $\frac{1}{2}$ inch, the distance between the centres being the same as between the electrode needles. Steel nails were driven into these holes in such a manner that they were not touching the sides of the holes. In this manner, the moisture gradient at various depths was determined in the sleepers.

Apart from the usual precautions given by the makers, it has been found that during the monsoon season, the ebonite panel, wooden handle, and other parts are likely to absorb moisture on the surface, which interferes greatly with the proper working of the meter. During a period of high atmospheric humidity, it is necessary to dry the instrument in an oven or a small kiln before use.

Working with hardwoods, we have found that when the needles are driven in, there is a tendency for them to come out and for this reason the handle should be kept well pressed in during the time a reading is being taken on the moisture meter. If the pressure is slightly slackened, the electrical contact between the wood and the electrodes becomes loose, with the result that the moisture content indicated is too low.

It may also be mentioned here that with woods containing large amounts of volatile constituents, such as deodar (*Cedrus deodara*), the resistance method gives more correct results than the oven-drying method. In a sample of deodar, which gave 13·4 per cent. moisture

with the oven-drying method, the results with the moisture meter and the distillation methods were 9·7 per cent. and 9·8 per cent. respectively.

II. The Blinker Moisture Meter.—This instrument was developed jointly by M. E. Dunlap of the Forest Products Laboratory, Madison, and C. G. Suits of the General Electric Company, Schenectady, N. Y. For determining the resistance of wood a neon tube circuit is employed, as shown in Fig. 2 (Plate 27). When the circuit is closed, the condenser (C) is charged through the resistance (R) which regulates the current flow, permitting a gradual building up of the voltage across the condenser. When this voltage reaches a certain value, there is a discharge between the two identical electrodes in the neon tube (N), which is accompanied by a characteristic reddish glow. Due to the discharge, there is a drop in the condenser voltage, which stops the flashing of the neon tube, until the condenser voltage is built up again to the required level, when the cycle is repeated. It is the intermittent flashing or "blinking" of the neon tube, which has given the instrument its curious name.

For determining the moisture content of wood, two such circuits as shown in Fig. 3 (Plate 27) are employed, one containing a known resistance (R_1) and capacity (C_1), which gives a constant pulsation of say one flash per second, and which serves as a standard for the purposes of comparison. The second circuit having a sample of wood for resistance (R_2) has a variable capacity (C_2), which is adjusted by means of a dial switch, till the rate of flashing in both the neon tubes is practically the same. The moisture content is then read off directly from the dial.

An instrument of this type is also in use at the Forest Research Institute, Dehra Dun, and the results obtained with it are nearly as reliable as with the Tag-Heppenstall meter. Detailed experiments with this meter are in progress, and the necessary correction table for common Indian woods will be available shortly.

Having worked with both types of meters described here, we consider that the Tag-Heppenstall instrument is much more con-

venient to use, and is certainly more rapid than the Blinker. Moreover we find that the needle electrodes can be made to penetrate into a sample of wood with less effort, and give a better electrical contact than the blade electrodes fitted to the Blinker.

III. The Hygrophone.—This instrument was designed by Prof. Nowak of Vienna. The mode of action of the instrument is stated to be as follows : The wood whose resistance is to be measured is connected in parallel to a condenser, which is connected to the grid of a radio valve. The condenser is charged by the secondary of an auto-transformer, the primary of which is connected to the anode plate of the radio valve. On switching on, the valve is operated and the characteristic anode current flows through the primary of the transformer. The grid and the condenser are charged negative due to potential developed in the secondary of the transformer, which stops the flow of the anode current. The condenser then gets discharged through the sample of wood connected to it in parallel, which restarts the flow of the anode current. The alternate stoppage of the anode current gives a definite click which can be heard on an earphone. The number of clicks per minute depends on the moisture content of the wood and by counting the clicks per minute the moisture content of the sample can be read off from the calibration table supplied with the instrument.

The meter is said to be largely in use in Germany, Austria and other parts of Central Europe, but it does not appear to be as rapid and convenient as the Tag-Heppenstall instrument. In the first place it is rather troublesome to count the number of clicks, and it would have been much better to employ two circuits, one standard and one variable as in the Blinker. Again, the instrument is designed to measure the moisture content of an entire cross-section, as one electrode is placed on one side of a plank and the second electrode on the opposite side. With the usual moisture gradients as found during air and kiln-drying, the results would certainly be erratic. In the case of air-dried planks with uniform moisture distribution, fairly accurate results may, however, be expected.

4. Dielectric Method.

This is based on the considerable difference between the dielectric constants of water and of wood. The former is 80 at 20° C., and the latter about 3 for a dry hardwood. It is, therefore, apparent that a small variation in the moisture content of wood will cause a large change in the resultant dielectric constant. This method is used chiefly for the rapid determination of the moisture content of cereals such as flour, etc., and various forms of apparatus are on the market. The results are said to be influenced considerably by the size of grains, the amount of air spaces between the grains, the density of packing and even with different varieties of the same cereal (*vide* E. Rammler : *Archiv Wärmewirt*, **13**, 1932, 203-9). Cook, Hopkins and Geddes (*Canad. Jour. Res.* **11**, 1934, 409-47) found that the dielectric type of moisture meter was of little practical value for the rapid determination of moisture in grain. For the rapid determination of moisture content of brown coal, the method based on the variation in dielectric constant, as suggested by Berliner and Rüter, was awarded the first prize by the German Brown Coal Industry Association.* A suitable meter on this principle, called the "DK" rapid moisture meter is manufactured by Heilan, G. m. b. H., Frankfurt a M, Germany.

For the determination of moisture content with "DK" moisture meter, Mörath (*Kolloidchem. Beihefte*, **33**, 1931, 132) has described the procedure, and has given calibration charts for beech, oak and pine, in thicknesses of 10 mm., 25 mm. and 40 mm. and for a range of moisture content from 0 per cent. to 30 per cent. The chief disadvantage is that the readings are affected by the thickness and the species of wood which necessitates a large number of separate calibration curves. J. S. Rankin (*Jour. Roy. Tech. Coll., Glasgow*, **3**, 1931, 212-17) states that working with the capacity method, a difference of 0·01 inch in thickness is equivalent to 1 per cent. moisture. Moreover initial knowledge is required with regard to the dry condition of every variety of wood to be tested, so that the initial settings of the condensers may be obtained. In the "DK" apparatus the results can be erratic as the condenser plates, which are placed on the opposite

sides of the plank to be tested, measure the total dielectric capacity of the board, which in the case of irregular moisture distribution would not give any correct indication of the true state of affairs. On the other hand, the moisture content range of the instrument is greater than that of the electric resistance method. In countries, where the number of species handled by the timber trade is not large, and where the thicknesses are standardized, the dielectric method may give useful results in case of well seasoned material with uniform moisture distribution, but any universal application of this method appears to be out of question.

SUMMARY.

1. The methods employed for the rapid determination of moisture content of wood are based on four different principles, namely :—

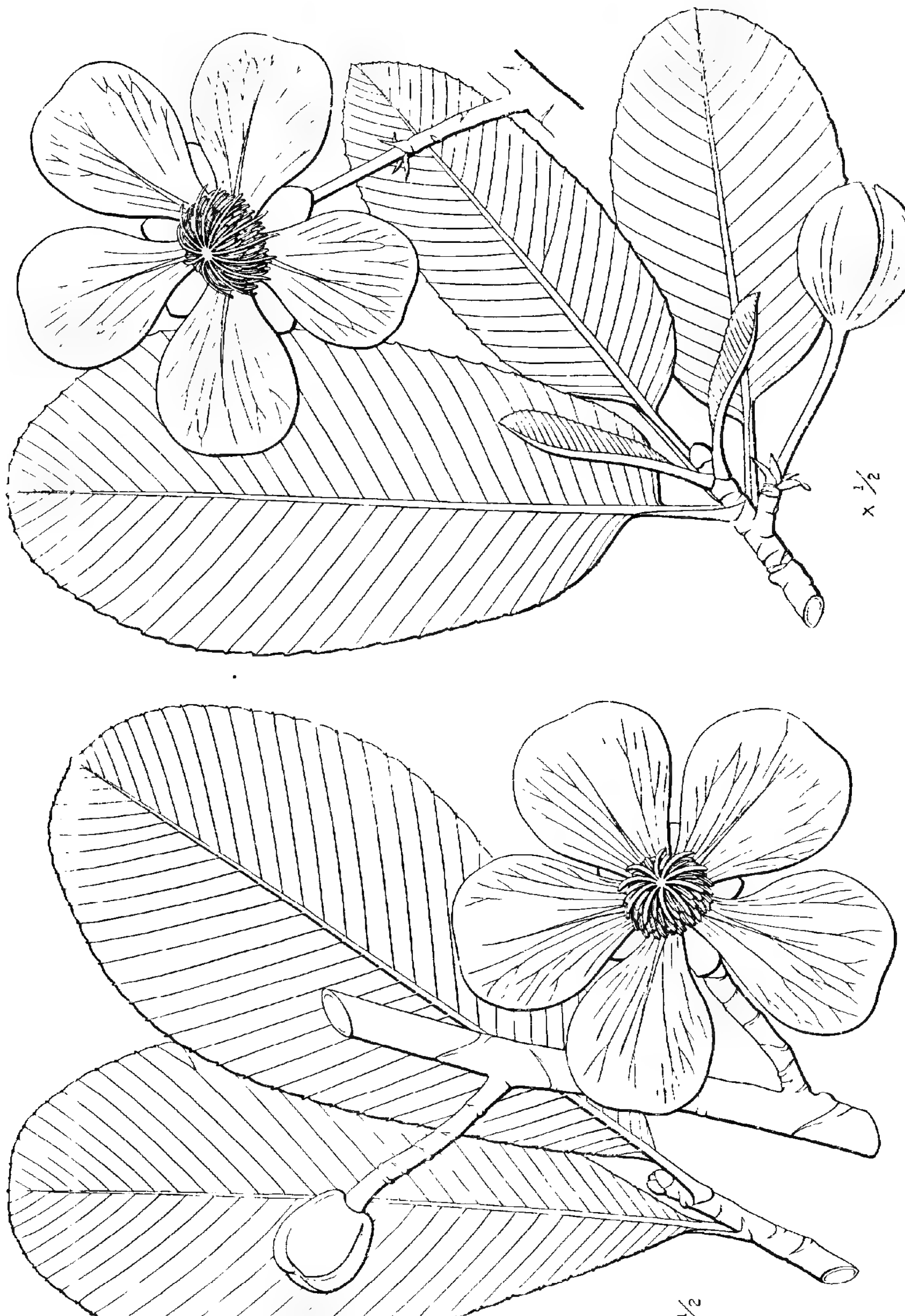
- (*i*) The change in relative humidity of air in the immediate neighbourhood of the piece of wood to be tested.
- (*ii*) The distillation of the specimen with an organic liquid immiscible with water, having a boiling point between 100° C. and 150° C.
- (*iii*) The change in the electric resistance of wood with variation in its moisture content.
- (*iv*) The change in dielectric constant of wood caused by the presence of moisture.

The advantages and disadvantages of the various methods are discussed.

2. The electric resistance method is the most convenient to employ and within the range 7 per cent. to 24 per cent. moisture content, the results obtained on Indian woods with the Tag-Heppenstall moisture meter are very satisfactory.

3. A correction table is given for some of the more common Indian woods for applying to the readings of the Tag-Heppenstall moisture meter.

4. A method is described for determining the moisture gradient in thick timbers with the Tag-Heppenstall moisture meter by the use of steel nails.



x 1/2

Fig. 2. Dillenia aurea Smith.

x 1/2

Fig. 1. Dillenia ornata Wall.

Ganga Singh del.

ON SOME INDIAN AND BURMESE DILLENIAS.

By C. E. Parkinson, Forest Botanist, F. R. I., Dehra Dun.

While studying herbarium material of the Indian and Burmese *Dillenias* the writer has become aware of certain misconceptions regarding the identity of some of the species which it is endeavoured to explain and clear up here. The species involved are the large yellow-flowered ones belonging to Section C in Brandis's paper on the Indian *Dillenias* in the *Indian Forester*. Vol. XXVI (1900), pp. 429-431. That Brandis was not satisfied with this section, is evident from his remarks in this paper and in Indian Trees. Hitherto *Dillenia ornata* Wall, has been reduced under *D. aurea* Smith and *D. pulcherrima* Kurz maintained but, as the writer proposes to show, the two former are distinct and it is the last mentioned species that should be reduced.

Dillenia aurea Smith was described in 1806, in Exotic Botany, from a drawing made by Lieut.-Col. Hardwicke, who found it in the jungles and thickets east of the river Gogra, *i.e.*, the present districts of Bahraich, Gonda and Gorakhpur of the United Provinces. Smith, according to his own statement, saw no specimens of the plant, but based the species on Hardwicke's drawing. No uncertainty is felt about the identity of this plant for the description and figure can only be associated with one of the three *Dillenias* occurring in the area mentioned, the other two that occur there, *i.e. D. indica* and *D. pentagyna* being sufficiently distinct. The plant described under *D. aurea* by Duthie, Haines and Kanjilal can be none other than Smith's plant and the herbarium specimens from these districts quoted below may therefore safely be taken to represent *D. aurea* Smith ; if not, further confusion can only result.

Smith's plate, however, is not altogether good. It depicts the flowers correctly, but fails to show in the single leaf drawn the characteristic, almost spathulate, sudden narrowing of the unequal leaf base and the long petiole (see plate 28, fig. 2). This is one of the distinguishing features of the plant. It will be more correct, therefore, if further comparisons are made with the specimens themselves and not with the drawing. Where no doubt exists as to identity, the type for further

study should be the plant itself, or a specimen of it, rather than a drawing.

Dillenia ornata Wall. was described and figured in Plantae Asiaticae Rariores in 1810 from Martaban. Wallich himself saw the tree during his visit to Burma in 1827 and his specimens from the Ataran and Amherst may therefore be regarded as the types. Wallich's description of the plant is good and his plate is excellent.

Kurz, among others, dealt with three allied species of *Dillenia*—two from Burma which he described under the names *D. aurea* and *D. pulcherrima*, and a third from the Andaman islands under *D. pilosa*. He quite correctly recognised one of the Burmese plants to be *D. ornata* Wall., for Wallich's plate and description of that species leave no doubt as to its identity, but, misled by Smith's plate on which his conception of *D. aurea* was evidently based, he erred in also identifying this plant with Smith's and therefore described it under the older name quoting *D. ornata* Wall., in synonymy (see *Journal of the Asiatic Society of Bengal* 43, 2 (1874, p. 46). He was now left to deal with the second Burmese plant and having accounted, as he thought, for both *D. aurea* Smith and *D. ornata* Wall., he gave it a new name *D. pulcherrima*. From the large suite of specimens, both Indian and Burmese including Kurz's, now available for examination, it is quite evident, however, that this plant is identical with the one from east of the Gogra, *i.e.*, the true *D. aurea*. It follows therefore that *D. pulcherrima* Kurz=*D. aurea* Smith and *D. aurea* Kurz (non Smith)= *D. ornata* Wall.

From the herbarium specimens quoted and a knowledge of both the plants in the field, the writer is of the opinion that *D. aurea* Smith and *D. ornata* Wall. are distinct species. Kurz also recognised that these plants were distinct but only confused their identity and in his treatment of them and the reduction of *D. ornata* Wall. he was only followed by Hook. f. and Thoms. in the Flora of British India and later by Brandis in Indian Trees.

A *Dillenia* from the Andaman islands has already been mentioned. Kurz first took this plant to be *D. pilosa* Roxb. and dealt with it

under that name in the *Journal of the Asiatic Society of Bengal,* Vol. 42, 2 (1872) p. 291 and 43, 2 (1874) p. 46 and in the *Forest Flora of British Burma,* p. 20. but later he also realised that it could hardly be Roxburgh's plant and wrote regarding it in the *Journal of the Asiatic Society of Bengal,* Vol. 45, 2 (1876), p. 115, as follows:—"I formerly identified this tree with Roxburgh's, but now I entertain great doubts as to the correctness of my identification, having ascertained that the insular species is a southern form which is unlikely to extend so far north as Assam."

Dillenia pilosa Roxb. has been reduced in the Flora of British India to *D. pentagyna* and this reduction would appear to be correct. Roxburgh's description is too inadequate for recognition; it fits more than one species of *Dillenia* and cannot, with certainty, form the basis of any. The tree is said to grow "in the vicinity of Goalpara on the banks of the Megna" where *D. pentagyna* is known to be common. If it were distinct it is very unlikely that it should not have been found there again during the last century or more. It was, indeed, specially searched for by Hamilton in 1810 (*vide* Trans. Linn. Soc., Vol. 15 (1827), pp. 102, 103), but the plant that he described from Goalpara on the basis of locality as *D. pilosa* has been shown in the Flora of British India to be *D. scabrella*.

Roxburgh's plant should be looked for in Assam or Bengal and until found there his name *pilosa* should not be associated with one that appears to be endemic in the Andaman (and Nicobar) islands, for the one described below has not been found elsewhere. For this plant the writer proposes the name *D. andamanica*. In the Calcutta herbarium there are some herbarium sheets with young leaves only collected by Kurz at Kamorta in the Nicobar islands to which he has given the mss. name *D. nicobarica*; as Kurz himself realised these are very likely the same as the Andaman plant but, in the absence of flowering specimens from the Nicobars, the writer prefers not to use Kurz's unpublished name for the Andaman tree; the Nicobar one, when better known, may prove to be distinct.

The following is a key for these three allied species :—

Flowers 3-5 in. across ; peduncles stout terminating short branches or near the terminal bud.

Leaves obovate-oblong abruptly and unequally narrowed into the 1—1½ in. long petioles ; peduncles 1-3 in. long styles 10-12 .. *D. aurea.*

Leaves obovate gradually narrowed into the short ½ in. petioles ; peduncles up to 1 in. long ; styles 9-10 .. *D. ornata.*

Flowers 2½—3 in. across ; peduncles slender, from short warty nodules along the branchlets. Leaves narrowly obovate or oblanceolate with short petioles ; styles 6-8 .. *D. andamanica.*

The conspectus of the species of *Dillenia* given by Kurz in the *Journal of the Asiatic Society of Bengal*, Vol. 43, 2 (1874), p. 46 and his key for the *Dillenias* given in the *Forest Flora of Burma* 1, p.19, hold good for these three species if, instead of the names *D. pulcherrima*, *D. aurea* and *D. pilosa*, the names *D. aurea*, *D. ornata* and *D. andamanica* respectively be read. In the key in the Forest Flora the remark "petioles long" against *D. aurea* may be misleading, but in the description of the plant under that name the correct length 5-6 lin. (about half an inch) is given.

Dillenia aurea Smith Exotic Botany 2 (1806), p. 65, tt. 92, 93 ; Ham. in Trans. Linn. Soc. XV (1827), 101 ; Hook. f. and Thoms. in Fl. Brit. Ind. 1, p. 37, *partim ;* Brandis Ind. Trees p. 4, *partim ;* Duthie Fl. Upper Ganget. Plain p. 21 ; Haines Bot. Bihar and Orissa, p. 7 ; Kanjilal For. Fl. Pilibhit, Oudh, Gorakhpur, p. 3.

D. pulcherrima Kurz in *Journal of the Asiatic Society of Bengal* 40, 2 (1871), p. 46 and 43, 2 (1874), p. 46 ; For. Fl. Brit. Bur. 1, 19 ; Brandis Ind. Trees 4.

Distribution.—In the sal (*Shorea robusta*) forests of Oudh, Bihar and the Central Provinces and in the dry *Dipterocarp* (*In* or *Indaing*) forests of Lower Burma associated with *Dipterocarpus tuberculatus, Shorea obtusa* and *Pentacme suavis.*

Herbarium specimens seen :—

United Provinces. Gorakhpur district, Daibhar, *Harsukh* 21380, 24 April 1898; Chauk, *Shri Ram* 10, 13 May 1916; Nepal frontier, Barhantar nala, *Inayat* 23550, 16 May 1900; Gonda division, Bhamar, *Sus Ram* 18, 15 May 1916.

Bihar and Orissa. Madalphari hill, Musnea bungalow, Sonthal Parganas, *J. P. Haslett* 7/1585, 29 April 1907; Singhbhum *H. H. Haines* 21, leaves 13 December 1902, flowers April 1903.

Central Provinces. South Mandla Division, *Forest Ranger* (without number), "In frosty places," 17 May 1914.

Burma. Toukyeghat, Seven Pagodas, *S. Kurz* 40; Pegu Yomas, east slopes, *S. Kurz* 1807; Shan hills, *Abdul Huk* 86, 1892; Kachin hills, Myitkyina, *Sheik Mokim*, March 1898; Anisakan near Maymyo, *J. H. Lace* 6193, 25 May 1913; Tharawaddy near Taukte, *C. G. Rogers* 291, 13 April 1914, vern. *Byu*; Magwe, Natmauk-Kyagan road, *C. G. Rogers* 963, 15 March 1915; Maymyo, Circular road, *A. Rodger* 263, 11 April 1915; North Toungoo, in *Indaing*, *A. Rodger* 2, 8 June 1915, vern. *Linyaw;* Mergui, Lenya, *R. N. Parker* 2668, 22 February 1929; South Pegu, Salu Reserve, *Maung Ba Pe* 2528 (with timber specimen) 7 March 1926, vern. *Byu*; North Toungoo, East Swa Reserve, *Maung Ba Pe* 9491, 1 April 1919, vern. *Linyaw;* Pyinmana Division, Zalokkyi, *C. E. Parkinson* 9754, 26 April 1929, vern. *Linyaw*.

Dillenia ornata Wall. Pl. Asiat. Rar. 1 (1830), p. 20, t. 23.

D. aurea Kurz in Journal of the Asiatic Society of Bengal 43, 2 (1874), p. 46 and in For. Fl. Brit. Bur. 1, p. 20; Hook. f. and Thoms. in Fl. Brit. Ind. 1, p. 37, *partim;* Brandis Ind. Trees p. 4, *partim*, non Smith.

D. speciosa Griff. Notul. 4. p. 703 et Icon. t. 649, f. 3.

Distribution.—In mixed deciduous forests in Martaban and Tenasserim. Not known to occur in India.

Herbarium specimens seen :—

Burma.—Amherst, *Wallich* 1612, 17 Febr. 1827; Ataran, *Wallich* 947, March 1827, Myitnagan valley, dry forests above Plumadoe, *S. Kurz* 40/6; Martaban hills, Bithokho, *D. Brandis*, March 1880;

Tenasserim, Pagayi, *A. Meebold* 15199, April 1911 ; Mergui district, Tenasserim river, Chaungnaukpyan, *C. E. Parkinson* 1604, 17 Jan. 1929, vern. *Zinbyun* ; Victoria Point, Maliwun, *C. E. Parkinson*, 2040, 20 March 1926, vern. *Zinbyun* ; Victoria Point, Kampong Talok, *Sakoe* 7603, 17 Jan. 1928, vern. *Zinbyun*.

Dillenia andamanica C. E. Parkinson sp. nov. (Dilleniaceae-Colbertiae) : a *D. aurea* Smith et *D. ornata* Wall. foliis oblongo-oblanceolatis, pro rata angustioribus, floribus minoribus, pedunculis gracilicribus saepius binis, stylis 6-8 recedit.

D. pilosa Kurz in Rep. Veg. And. Islds. (1870), App. A p. 29 (nomen) ; *Journal of the Asiatic Society of Bengal* 41, 2 (1872), p. 291 and 43, 2 (1874), p. 46 and 45, 2 (1876), p. 115 ; For. Fl. Brit. Bur. 1. p. 20 ; Parkinson, For. Fl. Andaman Islds. (1923), p. 71 ; non Roxb.

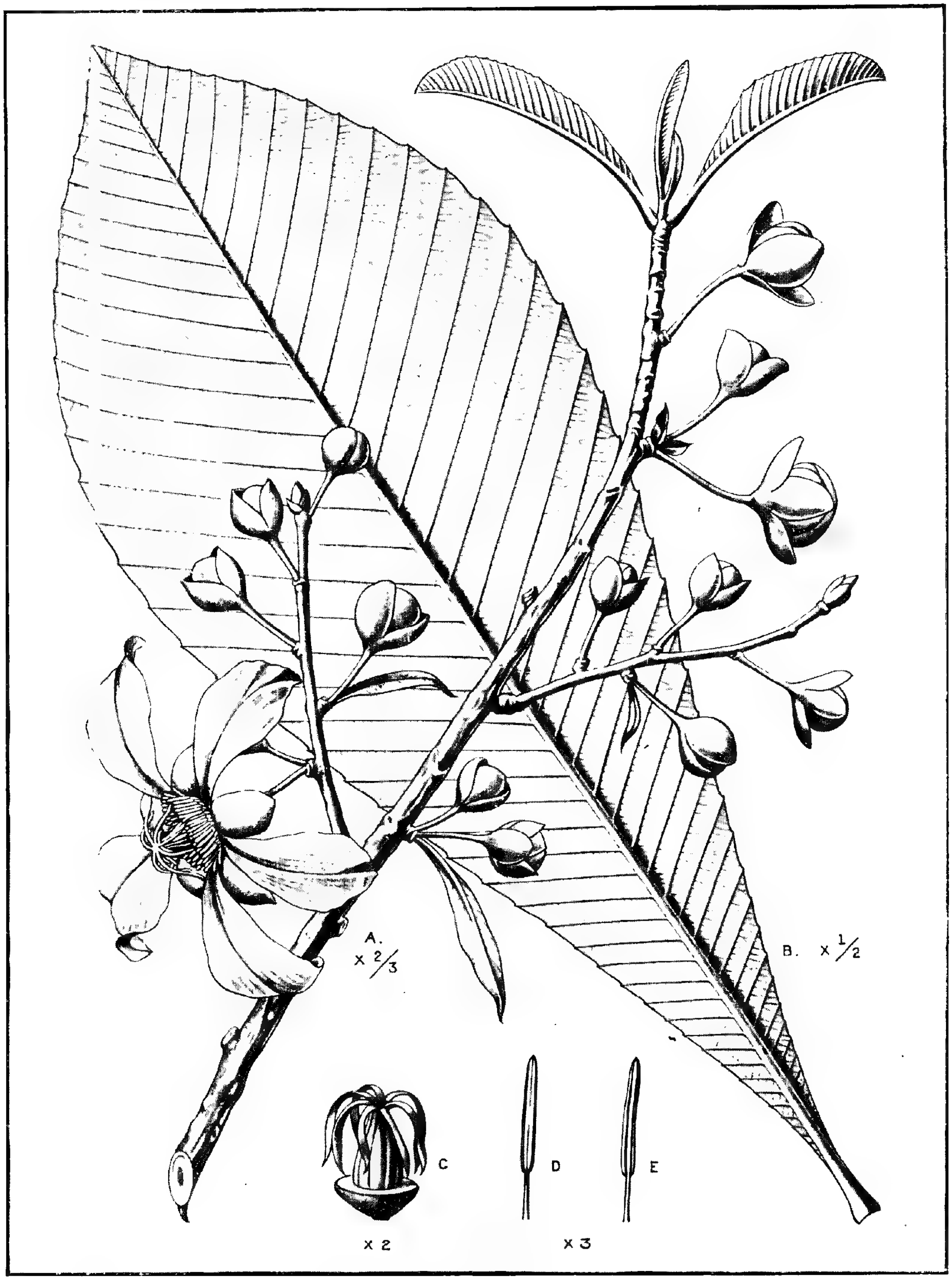
D. parviflora Hook. f. & Thoms. Fl. Brit. Ind. 1, p. 38, quoad sp. andamanens., non Griff.

A tree of irregular growth attaining 40 to 60 feet in height. Leaves narrowly obovate or narrowly oblong-obovate or oblanceolate, apex bluntly pointed, base gradually narrowed to the short petiole, 25—40 cm. long, 9—15 cm. wide, margin undulate serrate, glabrous above, thinly pubescent beneath, lateral nerves numerous, about 40 pairs or so. Flowers yellow, 5-6·5 cm. diam., solitary or paired, from small warty nodules on the branchlets below the leaves and appearing with or before the new foliage ; pedicels 2-3·5 cm. long, slender, silky pubescent like the exposed portions of the calyx ; sepals 1·5 cm. long by ·8 cm. wide ; petals 3 cm. long by 2·2 cm. wide, narrowly obovate ; stamens numerous, those of the inner series with longer filaments and anthers than those of the outer ; styles 6 8, ovary glabrous. Fruit about 2·5 cm. diam., thinly hairy and orange coloured when ripe.

Distribution.—Mixed deciduous forests of the Andaman (and Nicobar) islands.

Herbarium specimens seen :—

Andaman islands.—South Andaman, Aberdeen, *S. Kurz* 1875 ; Middle Andaman, at Middle straits in the bamboo jungles, *S. Kurz* ;



Ganga Singh del. *Dillenia andamanica*. C. E. Parkinson.

South Andaman, *Dr. G. King*, April 1890; Andamans, *Dr. Prain's collector*, April 1892; Middle Andaman, Bomlungta, *C. E. Parkinson* 1185, 12 April 1916 (type) and 581, June 1915; Middle Andaman, Porlob Island, *Kirat Ram* 3789, Febr.-March 1934.

The following gathering, which appears to represent leaves from young plants, is also probably referable here :—Nicobar Islands, Kamorta, *S. Kurz* 2/75.

THEORY OF IRRIGATION AS APPLICABLE TO THE PUNJAB IRRIGATED PLANTATIONS.

By Bahadur Singh, P. F. S.

Irrigation.

Irrigation is the artificial means of supplying water to the crops for the attainment of normal growth and yield in localities where rainfall is deficient and the water table is too low.

The crops receive irrigation by means of well watering or flow watering from a canal system. For the purposes of irrigated plantations, the latter is the best and most economical method.

A canal is designed primarily to supply water to cultivators on field irrigation basis. Excess supply to plantations, not originally provided for in the project, is not possible without payment of exorbitant water rates, which if paid, leave little or no margin of profit to the Forest Department. Economy in the use of water consistent with the normal growth of crops is, therefore, highly desirable.

In this article an attempt has been made to combine theory with actual irrigation practice and its study will show how best economy could be effected under different conditions.

Movement of water in the soils.

After the delivery of water the upper layers of soil are at first wetted, but as the water moves downward by gravity the plants have absorbed their share and the surplus water in excess of full capillary saturation of soil sinks below the sphere of root action and adds to the standing water

table. With the drying of top soil however a steady upward movement of water takes place to supply the loss of evaporation resulting from surface soil ; the larger the evaporation, the lower the moisture down in the sphere of root action.

Lateral movement is always slower than the downward movement, but it varies with the nature of soil. In clayey soil it is greater than sandy, *rappar*, and *kallar* soils. To assist lateral movement and also where economy of water is desired, furrow irrigation is usually resorted to. If furrows are near each other the moisture film moving horizontally meets at certain depths depending on the nature of soil and the quantity of water given.

Trench irrigation in the plantations serves the purpose of furrows. The moisture contents in the plantation soils are dried up to varying degrees according to the nature of soil before *kharif* irrigation commences after a period of cessation of water supply for six months.

When irrigation is delivered for the first time the moisture movement is slow in both ways, but with subsequent repetition of waterings it increases and meets from trench-to-trench.

Mulching as means of conserving soil moisture.

When the top soil is ploughed or loosened the surface evaporation is checked since the point of contact between loose and compact soil below is broken. The greater the intensity of cultivation the lesser the evaporation losses and greater the possibility of conserving soil moisture.

Under *taungya* system evaporation losses are considerably reduced by ploughing the land between the rows of shisham cuttings put out along with field crops. In this manner, the water requisition for initial stocking with shisham cuttings is reduced by no less than 50 per cent.

The soils shaded by trees present self-mulching conditions. With the completion of leaf-canopy and presence of humus on the ground the evaporation losses are checked and the soil moisture so conserved is released gradually for the benefit of crop.

Capillary movement of water in different soils and their relative effect on growth.

Capillary water as it rises to the surface is absorbed by small root hairs of plants by osmosis. When soil has reached a point at which capillary movement has become too inactive, it is then that the plants are in need of watering ; but if the water is withheld, the soil-moisture having been reduced to wilting coefficient, the plants begin to show signs of drought.

Soils such as *kallar*, *rappar* and sandy soils are more susceptible to drought action than loam and clayey loam soils owing to their fineness and consequent slow capillary movement and low-moisture retentive capacity. The shisham crop exhibits signs of drought which is indicated by slight discolouration and wilting of leaves, and the experienced forester at once realizes the necessity for adding water to the soils.

Although water moves freely after each irrigation, yet larger proportion of it is held near the surface layers where roots function. Owing to abundance of root system near the surface, which is also characteristic of shisham grown in plantations, the soil-moisture is often reduced to wilting co-efficient unless watering is repeated in such quantity and at such interval that it would raise the soil-moisture to its full capillary saturation to a depth to which root action is active.

A careful irrigator uses water economically, so that very little passes below the sphere of root action. If, on the other hand, water is given in excess of full capillary saturation, it is bound to be wasted below the zone of root action without adding in the least to the growth of crops.

This fact has been amply demonstrated from the results of experiments conducted by the Research Institute, Dehra Dun, in Chichawatni plantation. These experiments had for their object the determination of variation of height growth in relation to the different depths of water delivered in different soils, *viz.*, loam called average soil and *kallar* soil. The former received depths of water varying from 3 to 7 feet and latter 7 to 12 feet, each depth being 3 inches. The analysis of data summarised for three years showed the same results,

i.e., on average soil represented by several plots, the gain in height growth following on giving additional water above the minimum of 3 feet tried in each case was nil or relatively so small as to be insignificant. Thus, in other words, the extra water given over 3 feet all went to waste without adding to the height growth. Exactly similar results were obtained in *kallar* soils.

Classification of irrigation.

Dr. John A. Widtsoe classifies the depth of irrigation that may be given each time for field crops into three classes; a light one of 3 inches; a heavy one of 8 inches; an average one of 5-6 inches.

The Canal Department has fixed it at 3 inches, although according to statistics it works out to 6 inches.

Flooding in Changa Manga takes 2-2½ feet depth per irrigation. Under trench method a deep or heavy irrigation works out to 12 inches. A shallow or light irrigation absorbs 3 to 4 inches and a medium one 5 to 6 inches.

Effect of various kinds of irrigation on soil moisture.

According to Dr. John A. Widtsoe's observation a light irrigation raises the soil-moisture to 18 per cent. to a depth of 12 inches at a time; a heavy one raises soil moisture to 24 per cent. to a depth of 24 inches in dry loam soil, but if the soil contained 12 per cent. moisture of a previous irrigation one heavy irrigation would raise 4 feet depth of soil to its capillary saturation.

Flooding (2 to 2½ feet depth each) would undoubtedly raise the soil to its full capillary saturation to a depth to which root system of shisham is active, but much of this is bound to be wasted by absorption below the sphere of root action and the rest evaporated owing to the extent of larger wetted area exposed.

A deep irrigation in trenches would likewise saturate the soil, but with a fixed delta of 4 feet it can only be repeated 4 times after every 1½ months during irrigation season. Thus, long before the repetition of watering becomes necessary the soil-moisture reaches wilting coefficient and the plants suffer from drought. Such damage

is greater on shallow, *kallar, rappar* and sandy soils. With the same delta, a light irrigation can be repeated 12 times or one irrigation after every fortnight. In actual practice, however, the two preliminary irrigations, which ordinarily absorb 5 to 6 inches depth per watering, raise the soil-moisture to its capillary saturation to the depth of root action; and subsequent irrigations assisted by rains in the season reduce the depth per watering due to the presence of soil moisture of previous irrigations.

Frequency of irrigation.

Frequency of irrigation depends on following factors :—

(*i*) Depth of soil :—Assuming the average percentage of soil moisture to be the same in both deep and shallow soil the larger will be the loss of water from deep soil in the given period. Even though deep soil loses heavily, but being possessed of large volume of water in proportion to its depth will still hold more water on the same rate of evaporation than shallow soil. Deep soil will, therefore, require less frequent irrigation than shallow soil. In some cases a hard pan is formed below the surface soil, which does not allow penetration of moisture. Such soils, which occur in certain plantations, dry out quickly and need irrigation frequently.

Kallar soils rich in soluble salts are impervious to water and are equally less evaporative due to slow capillary movement. *Rappar* soils contain about 4 to 5 times more soluble salts than clayey loam and sandy loam and are equally impervious but more evaporative. In these soils deep irrigation at fairly long interval would be required.

(*ii*) Root system :—If the roots are developed near the surface more water will be used from top layers of soil than if the roots were distributed throughout the depth of ground. Young roots are more active in absorbing water than older ones. In the case of shisham grown in plantations the active root system extends only 4 feet below ground level, the tap root merely functioning as a support in localities where water table is low. Two preliminary medium irrigations followed by light irrigations repeated at reasonably short intervals maintain full capillary saturation to the full depth of root action.

(*iii*) State of crop :—At the time of initial stocking, when plants have not yet developed their root system, light irrigation repeated at very short intervals supplies the evaporation losses, which are greater in the exposed condition of soil. Crop raised from sowings absorbs more water than cuttings due to keener root competition and requires watering more frequently. But as the canopy closes up the frequency of irrigation is lessened.

(*iv*) High temperature, low humidity and winds dry out moisture necessitating frequent irrigation. While proximity of sub-soil moisture and intensity of rainfall are favourable factors lessening the demand on irrigation water and its frequency.

(*v*) Zerophytic species make less demand on water and require less frequent irrigation than mulberry and shisham.

Economical method of irrigation.

As stated above, an economical method is one of furrows for field crops or trench system for plantations.

For plantation the supply of water which is limited is the governing factor in determining an economical method of irrigation. Flooding absorbs larger depth per watering to admit the possibility of repetitions and is a wasteful method. A deep irrigation in trenches, apart from being detrimental to growth on certain soils, is uneconomical. A light or shallow irrigation well distributed over the season affords larger number of repetitions and comparatively takes less delta on the same quality of soils. The more the number of irrigations within reasonable limits the better the growth and lesser the depth per watering.

Trenches in *kallar* soil of whatever depth collapse immediately after irrigation, due to loose and powdery texture of soil, and thus to deliver deep irrigation in this soil by digging deep trenches is of little or no use. The nature of the soil and depth varies considerably at short intervals in each plantation and the variations are so interspersed that it becomes impossible to deliver deep or light irrigation according to the nature of the soil without effecting general lay-out and irrigation scheme for each plantation. The whole scheme for

each plantation is, therefore, based on the delivery of light irrigation, but in lieu of deep irrigation greater number of waterings are delivered according to the condition of the crop largely influenced by the quality of soils. Light irrigation also determines the depth of trenches to be dug.

Optimum number of waterings and delta delivered.

The factors enumerated under "frequency of irrigation" largely determine the optimum number of waterings and delta that may be delivered to obtain normal crop in different localities.

The conditions of water supply also have an important bearing on growth relevant to the number of waterings delivered. On a canal like Lower Bari Doab Canal, where water supply is constant and regular between 1st April and 15th October, the delivery of optimum number of waterings and delta results in normal growth of crop. While on a canal like Sutlej Valley Project, where except for flood months (July to September) the supply is meagre and irregular, the number of waterings even if delivered in excess of the optimum determined in the case of the former do not produce normal crop; although it has been observed that the crop adversely affected in a year of short supply has recouped in the following favourable year, thus the cumulative effect of the past good and bad supply of water has not entirely retarded the growth nor has killed the crop, except on *kallar* and *rappar* soils, but has produced second quality shisham crop.

It will be interesting to record here the figures about optimum number of waterings and delta which yielded the above results under two different conditions of water supply. On deep loam with 33 per cent. *kallar* area in Chichawatni plantation (commanded by Lower Bari Doab Canal) the shisham crop maintained its normal growth on receipt of 9 waterings (each being 4 inches deep on average) or a total delta of 3·24 feet (average of the past three years) during *kharif*; out of these the normally grown crop received 8 waterings and backward represented by *kallar* soil received 10 waterings. The total delta (3·24 feet) is in exact accordance with the one actually utilized for field crops. While on shallow loam soil in Arafwala and

Dipalpur plantations (commanded by Sutlej Valley Project Canal) the crop received on average 11 waterings (each being 3·6 inches deep) or a total delta of 3·3 feet during *kharif*.

Irrigation practice in plantations.

Flooding is in vogue only in Changa Manga plantation. The water is let into one or more compartments according to the capacity of irrigating channels until the whole area is submerged. Where ground is level, the flooding is concentrated in one acre plots.

Trench system is almost universal in all the other plantations. For economical distribution of water lay-out is the first importance. The principle involved in the lay-out of a compartment for trenching is the equitable distribution of water run in the trenches, alongside which trees grow and flourish, for the purpose of quickly filling them within the shortest possible period. The larger the area a day-cusec covers the greater the economy in water and lesser the cost of irrigation. Keeping this object in view :—(*i*) smaller sized khals of $1\frac{1}{2}$ cusecs discharge, laid out at short intervals, are designed to run at full capacity, (*ii*) the length of trenches is curtailed to 70—90 feet by laying across them cross roads (cross-wise trenches) to eliminate unevenness of ground for the easy flow of water from pasel to pasel, (*iii*) the area irrigated at a time with two side-wise khals running parallel to pasels is reduced to $\frac{3}{4}$ acre for effective irrigation, and (*iv*) trenches are periodically kept clean of grasses and weeds. For the mode of irrigation and detailed layout see "Plantation Manual."

Preparation of a stock map of the existing crop is another necessity. This map serves a good guide to regulate number of waterings according to the conditions of the crop. Backward crop, influenced by poor soil, comes into leaves much later than normally grown crop, and as such receives preliminary watering earlier in preference to the latter, and continues to receive additional waterings even later in the season to accelerate its growth.

THE ADVENTURES OF A PYTHON

By S. Sundravarada Chariar, Range Officer,
Mettupalayam.

The following is an account of an encounter with a python 11 feet long $1\frac{1}{2}$ feet in girth in the jungle of Nilgiri Eastern Slopes, Mettupalayam Range, which I hope will be of interest to the readers of the *Indian Forester* :—

On 30th March, 1935, while I was engaged along with a Forester and several Irula coolies in the enumeration of dead sandalwood trees, looking round every bush in the sandalwood area in the Nilgiri Eastern Slopes of North Coimbatore District at about 4-30 P.M., we came to a locality partly semishola and partly scrub with a matting of heavy creepers smothering sandalwood trees young and old.

Just as the process of cutting creepers and freeing sandalwood trees continued we were startled by the hiss of something which began to move under the matted creepers of a neighbouring bush with a slow speed. A close watch revealed that a small reptile was having its sojourn in this place with impunity.

As we gazed from a distance of a few yards, the creature moved slowly to a basin like pit covered with dry leaves and wound its body in a curl round itself and thrust its head which was not visible underneath the dry leaves.

Some of us gathered courage and slowly approached the animal to have a look at close quarters. Lo ! we saw a big python encircling itself four fold with beautiful broken patches of dark and white on the upper portion of the body and emitting a most repulsive smell.

It was now a problem to dislodge it from its present position of vantage. Excepting one or two of the Irulars the rest were unwilling to provoke the animal, lest it should spring upon them and have an easy meal of one of them. Hence they took care to remain in a zone of safety and would not budge an inch. It took me nearly half an hour to instil courage into them, as I was all anxious to get rid of the monster and to make the area safer for our further work. The Irulars

still trembling with fear on the one hand that the monster would attack them in the event of their getting near it and on the other, that they would displease me if they kept silent any longer—set to work in right earnest by cutting creepers around the place where the beast was resting ; all this time the brute did not move a bit. To our utter dismay none of us had a gun though the necessity for it was very keenly felt. One of the Irula prepared a good long spike from a dead *Cassia fistula* branch and with its sharp end gave a thrust in the middle of the body, as the head of the animal was not visible. The other Irulars were gazing with doubtful courage with their aruvals raised ready to rend the animal into several pieces. I almost thought that the brute's end was near but unfortunately it was not to be at least for some time. The moment the spike tickled the brute, as it could not plunge deeper than the surface, its skin being so strong and hard to yield, out sprang the monster in the opposite direction with its huge long body exposed to full view. The Irula with the spike jumped to a side and his comrades with their spirits frozen and hearts beating at a high velocity ran in different directions, some of them even dropped down their aruvals and all their exhibition of courage vanished in a second.

It was a wonderful sight to see a jungle monster in full form ; instead of finding an asylum in a bush, rush forward and curl itself around a tall tree a few feet in front, and climb at the same time hissing with ferocity until it got to the top in 3 minutes and hung its head down as if looking and mocking at its enemies.

At the outset there was a good chance for the Irulars to manipulate with advantage their sharp bill hooks and successfully plunge them into its body. Unfortunately none of them had the courage to approach the animal but quietly acquiesced in its occupation of the position it had chosen. Once the animal was at the top of the tree, the courage of the Irulars seemed to return. Off went a volley of stones none of which injured the brute even slightly for some time. The Irulars were exhausted. There was not a ghost of a chance of the brute coming down that day, and this made the Irulars grow all the

more nervous to continue their work. I too got equally nervous, conscious of the fact that unfinished work in this area will be visited with unpleasant results from above. Realizing the seriousness of the situation and finding the futility of my rebukes I administered them for failing to take time by the forelock in despatching the brute by their aruvals, when it was just slowly making its way up the tree, I was obliged to change my attitude of anger to one of cajoling them by offer of reward. This had a magical effect. The Irulars exhibited their determination to finish the brute by some means or other. They again sent a volley of stones, this time some of them hitting and badly injuring the animal's mouth. Blood was dripping down and the injury appeared to have taken away its vigours and ferocity and the poor creature was reeling with agony making a hissing noise and frequently gaping its mouth, indicating exhaustion. Still it did not lose its hold and it was closely clinging to the tree thwarting all their attempts to dislodge him. Then we tied two "jallais" long jungle wood posts the top one having a hook at the end. The long "jallais" was raised slowly to a position which enabled the Irulars to hook the body of the animal successfully. All the Irulars pulled down the animal which appeared to cling to the tree more firmly than before. This struggle went on for a few minutes, the brute proving more than a match to the collective strength of the Irulars. At last after a desperate pull its weight on a slender branch gave way and the animal was brought down with a heavy thud. The moment it reached the ground, it made a desperate dash to the neighbouring bush but unfortunately for him the Irulars unlike before mustered sufficient courage and drew near him and gave series of cuts with their aruvals and some of them hurled big stones to crush its head. The further move of this poor creature having thus been effectively arrested, the Irulars inflicted series of injuries and after all succeeded in despatching him to the other world. Then a funeral pyre was got ready and the body of the python was placed on it and cremated amidst the characteristic songs of the Irulars.

Thus ended the life chapter of the python who, a few minutes before, made the blood of every one curdle. I have heard reptiles of

this magnitude getting up a tree and had also seen pictures of them. But this personal experience has convinced me of the truth of their extraordinary feats.

KUTH CULTURE IN THE PUNJAB HIMALAYA.

BY N. G. PRING, I. F. S.

In his most interesting article entitled "The Ecology and Culture of Kuth (*Saussurea lappa*, Larke)" which appeared in the *Indian Forester* of February 1935, Mr. Sher Singh was evidently unaware of the fact that *kuth* was grown and exported from Lahul. As a matter of fact, the head of the Chenab river is in Lahul and not, as stated in the article above, in Kishtwar. Lt.-Colonel Thompson, I. A., of the Survey of India, very kindly verified this with the official survey maps and gives the following details :—

The source of the Chenab is near the Bara Lacha Pass, 16,200 feet, where both the Chandra and the Bhaga rivers rise. These rivers meet below Kyelang, the capital of Lahul ; the Chandra, which is the greater river and becomes the Chenab below Kyelang, drains a large area of the great Himalaya range. The Chenab river leaves Punjab-Lahul to enter Chamba State about 20 miles below the junction. The distance from the source of the Chenab to the junction of its tributary the Kishtwar river is about 200 miles. The nomenclature and spelling is that of the official reference sheet ; locally and on some maps the Chenab is termed Chandra Bagha in Lahul and Chamba.

During August 1932 the writer saw *kuth* growing in orchard gardens of the Chandra and Bhaga valleys at elevations of over 10,000 feet. Photographs were taken and one of these is sent with this note (Plate 30, photo No. 3). The plants looked very healthy and some had reached man-height. The writer had no opportunity of getting away from the main valleys, where grazing both in and out of the forests is so excessive as to preclude the growth of wild *kuth*.

In the remoter and more inaccessible areas there are numerous birch forests, and indeed in many of the untread areas up to 12,000

2-year-old seedling teak, average height 3′.

2-year-old root and shoot cutting teak, average height 11′.

Kuth cultivation in Lahaul, Kulu Division, Punjab.

feet conditions would appear to resemble the optimum so clearly described by Mr. Sher Singh. There is no oak, a very heavy snowfall and very little rain, which, however, increases towards the Kulu and Chamba borders, where high level silver fir is found. For the export of *kuth* from Lahul, permits for definite quantities have to be obtained from the Divisional Forest Officer, Kulu ; this is to prevent smuggling. Of course the total quantity exported from Lahul is small, as compared with exports from Kashmir.

There is unfortunately little possibility of the Forest Department controlling the culture of *kuth* within Lahul, and it is probable that natural supplies will become exhausted eventually. In Kulu, where control measures by the Forest Department would be possible, the Upper Parbatti valley between Pulga and the Spiti border is perhaps the most promising area for its introduction. Here where the fir forests merge into broad leaved woods and Alpine pastures, birch is common. Rainfall and snowfall are heavy at Pulga, but farther up the valley the full blast of the monsoon is evidently checked by the high mountains at the heads of the Hurla and Sainj valleys because Spiti, where the Parbatti rises, is in the dry zone. Near Kir Ganga, one march above Pulga, the writer found *Edelweiss* in abundance, which is indicator of an Alpine climate. Mr. Hamilton, when Divisional Forest Officer, Kulu, actually saw and dug up *kuth* plants in the Solang Valley of Kulu.

SEEDLINGS *VERSUS* ROOT AND SHOOT CUTTINGS.

BY W. D. M. WARREN, I. F. S., D.F.O., KOLHAN.

I am sending herewith two photographs of teak, taken in December last, after two seasons' growth in Leda 6 plantation of this division. In the first photograph the plants are now 11 feet high from root and shoot cuttings planted out early in June 1933. Casualties are negligible

The second photograph shows plants from seedlings, transplanted late in July, from seed sown in May of the same year. At the end of 1933 they looked poor, miserable specimens only 6 inches high, but they now average 3 feet. Even so they are nearly a full year

in growth behind the root and shoot cuttings. Casualties were 50 per cent.

FIFTY-FOUR YEARS OLD SAL PLANTATION.

By Mohd. Shaukat Hussain, Forest Ranger, Ramnagar Division.

Professor Troup in his "Silviculture of Indian Trees," Vol. I, under *Shorea robusta* (sal) on page 105 says: "In the Ramnagar Forest Division various records exist of sal sowings in open grasslands ploughed up before sowing. Most of these have proved unsuccessful owing to damage from frost. The most important attempt was made over an area of 25 acres at Chopra on an open grassy blank on abandoned cultivation: the area is situated close to the base of the outer Himalayas on poor soil with sub soil consisting of a deep boulder deposit. Sal seed was sown about 1878 to 1880 in ploughed lines 15 feet apart, and other species were sown later to fill up gaps. In the earlier years the plantation was artificially irrigated by water channels, but the young plants were killed back by frost or drought for some years. In 1910 the lines were distinctly visible though somewhat patchy; the trees had a height of 20 to 30 feet, which though not good for an age of 30 years, is perhaps as satisfactory a rate of growth as might be expected in such an unfavourable locality."

What remains of this plantation has now put on an average diameter of 8·5″ at breast height and the height growth is about 50 feet. The accompanying photograph shows the plantation in its present stage.

Since 1933, Chopra is again being tackled—this time with the aid of *taungya* cultivation. A plot of about 50 acres was taken at first under *taungya* which included part of the 25 acres mentioned by Professor Troup. Soil conditions still remain unchanged, but there is very little frost now. The growth and development of the sal seedlings is decidedly promising, but it remains to be seen whether they will keep up the fast rate of growth so far exhibited or slow down with the advance of time. The average growth at 18 months is 2 feet while a few plants are above 3 feet, and one plant is 4 feet 8 inches,

Chopra Sal plantation from seed sown in 1878 to 1880.

Chopra Sal *taungya* 18 months old seedlings. One seedling 4' 8" high. Irrigated.

Chopra Sal *taungya* 18 months old seedlings, average height 2 feet.

The area is irrigated and this may explain the comparatively fast rate of growth of seedlings. The plantation is being extended annually.

A REFERENCE WORK ON INDIAN LIZARDS.

Fauna of British India, Reptilia and Amphibia, Vol. II, Sauria, by Malcolm A. Smith, M.R.C.S., L.R.C.P., pp. i—xiii, 1—440, 94 *figs.,* 1 *plate,* 2 *maps. London, February* 1935.

The world contains about 2,500 known living species of lizards and 218 of these occur in the Indian Empire. The present contribution to the *Fauna of British India* by Mr. Malcolm Smith revises and replaces the volume in this series that was prepared by Mr. G. A. Boulenger in 1890; it deals with ninety species more than does the earlier monograph.

The importance of lizards to forestry arises from their insectivorous habits which gives them a high but unappreciated value in the natural control of insect pests of trees. Nevertheless that aspect of their economic importance which looms largest in the eyes of the forest officer is the utilisation of lizard skins for the decoration

of fancy articles and high-priced shoes. The increased demand began about 1926, when manufacturers, finding no profit in animal leather owing to trade depression, turned to other sources of revenue. In 1933 India exported about two and a three quarter million reptile skins, a large proportion of which were skins of lizards of the genera *Varanus* and *Uromastix*.

There are six zoological species of *Varanus* or monitor lizards in India but the trade recognises many distinct varieties or commercial sub-species. "*Varanus salvator* has nine different trade names, each one representing a different area of country. Some of the variations can be associated with geographical areas, others may depend upon selection by the manufacturer, those with strongly keeled scales being placed in one group, those with smoother scales in another. The skins of *Varanus monitor* from the Bengal area command a higher market value than those from other parts of its range, owing to the fact that in the former the scales are smaller, narrower, and more raised."

The precise definition of the specific and distributional limits of the *Varanus* group provided by this *Fauna* volume will be found invaluable for the interpretation of the resolution of the 1935 All-India Conference for the Preservation of Wild Life which states that "Monitor lizard (except in the Punjab) is deserving of special consideration."

New and improved maps of the Indian and Indo-Chinese areas have been introduced in the present volume.

C. F. C. BEESON.

EXTRACTS

GRASS PINE, SEEDLINGS AND GRAZING

BY G. A. PEARSON,

Director, Southwestern Forest and Range Experiment Station.

[Early studies of ponderosa pine reproduction in the Southwest emphasized the value of protection to young seedlings against sun, wind and cold. Shade by trees, grass, logs and other objects was thought to be beneficial, if not indispensable. Later, the idea was advanced that such benefits as are derived from cover operate mainly through soil improvement, and that shelter of the seedlings themselves is rarely needed or may be positively harmful. The information presented in this article supports the latter viewpoint.]

Evidence accumulated between 1908 and 1918 was mostly in favour of the protection theory. Germination was universally better under some sort of cover than on bare soil exposed to the sun. Survival under cover was poor; but this was not considered significant, for did not the seedlings die everywhere? Of the few seedlings that survived the first winter and the following June drought, nearly all were destroyed by grazing animals or rodents, and so there was little opportunity to ascertain what other factors might figure in ultimate survival. An ungrazed experimental area on which the brush was scattered after logging in 1908, at first offered striking evidence that a brush cover favoured pine reproduction; but after a year or two the difference between brush-covered and uncovered areas disappeared. However, a small area plowed and heavily seeded in 1914 gave better survival on brush-covered strips than elsewhere. Two other areas fenced against grazing animals accumulated in ten years seedlings in numbers varying from practically none to over 200 per acre. Logging slash was not a factor, but it was observed that results were better on the sites of light grass cover than on bare soils or those occupied by luxuriant grass.

Abundant germination and survival in 1919 furnished an unusual opportunity to observe results under a variety of conditions. Studies during the period of 1919 to 1921 disclosed that the mere presence or absence of soil cover was less important than the character of this cover and the character of the soil itself. The significant findings are briefly summarized as follows:

" Next to climate, soil is the most important physical factor........Reproduction seems to be affected most by the physical condition of the soil, as determined by the proportion of sand or gravel which it contains. Where the soil is sandy or gravelly, reproduction is seldom a matter of serious concern. Clay soils, on the other hand, are unfavourable to reproduction. Clay is rendered more favourable by the admixture of large proportions of gravel or stone." Elsewhere in the text, organic matter is given as an additional element contributing to the porosity and generally favourable condition of soils.

" Herbaceous vegetation favours germination and protects young seedlings against excessive insolation, winter killing, and frost heaving; but after the first year these benefits are counterbalanced by the unfavourable effects of root competition and shade....Reproduction will usually succeed despite competition from the roots of herbaceous plants, provided that the latter do not attain abnormal density or luxuriance. Such a condition is likely to obtain on the richest soils unless the grass and weeds are held in check. Complete eradication of herbaceous vegetation is not considered necessary, and is distinctly undesirable if accompanied by packing of the soil as in overgrazing, or removal of the loamy surface layer as in deep plowing......"

The foregoing conclusions were based on extensive observations checked by numerous plots on which survival of seedlings was recorded at different seasons over a period of 3 years. The sites embraced different soils and types of grass and weed cover, both grazed and ungrazed; areas in the zone of tree shade and root activity, and similar areas from which the trees had been cut; areas covered by leaf litter and

logging slash, and areas denuded of all cover by logging, fire, overgrazing and cultivation. The records were maintained for several years after the initial study was finished, and observations are still being continued. Additional information obtained from year to year has amplified or modified the conclusions, but nothing has been brought to light that would warrant changes of a radical nature.

1928 Experiment.

Although the splendid stand of seedlings which started in 1919 suffered severely from browsing by sheep and cattle, there was, at the same time, much evidence in support of the opinion held by some foresters that the heavy grazing which prevailed before and for several years after germination aided the initial establishment of these seedlings by reducing grass competition. Grazing was lightened materially in 1926 and following years. Along with a decrease in damage to pine seedlings came a marked increase in height and density of bunch grasses, particularly Arizona fescue (*Festuca arizonica*). This gave rise to the fear that, in the effort to overcome the evils of overgrazing, the pendulum might swing too far in the opposite direction and thus hinder the establishment of additional seedlings.

In order to study this problem under controlled conditions, a series of experimental plots was laid out in 1928, within a fenced area (Sample Plot S 3 B) which had been closed to all grazing since 1910. An account of the progress of reproduction on this area has been given in a recent article. Seedlings had started in 1919 at an average rate of 61,000 per acre. They were originally most numerous under immediately surrounding groups of seed trees, but survival proved very poor in these situations. In grass stands of moderate luxuriance, where mountain muhlenbergia (*Muhlenbergia montana*), beardless bunch (*Blepharoneuron tricholepis*), or feather grass (*Andropogon scoparius*) predominate, both germination and survival were good, as evidenced by the fact that these sites are now well stocked. Where Arizona fescue predominates, seedlings during the first summer were as numerous as in the other grass associations, but practically all died within a few years. On heavily grazed areas of fescue outside the fence, however, there was better survival, despite grazing damage.

The 1923 plots were laid out in a nearly pure fescue association where seedlings were abundant in 1919 but failed later. Seven plots were included in the series. Two were left in their natural state; one was burned lightly before seeding, then left undisturbed; one was denuded by cutting the grass, below the root collar, leaving the ground surface undisturbed; and three were clipped to heights of 2, 6 and 10 inches, respectively. This clipping was repeated two or three times each summer, according to the rate of growth. Previous experience with rodents pointed to the necessity of excluding them. Accordingly, a rodent-proof fence was built around the plots. A parallel series was left unprotected.

In order to insure adequate and fairly uniform seedling, each plot of three square meters was sown with 600 pine seeds. Seeding was done in June before the summer rains began, and the soil was raked lightly wherever the cover permitted. Owing to deficient rainfall in the summer of 1923 no germination took place and, consequently,

the plots were resown in 1929. Copious and well distributed showers through July and August of 1929 resulted in excellent germination. Table 1 gives a record of seedling counts on the various plots over a period of 5 years.

The records in 1929 show good germination on all the plots, even when rodents were not excluded. Variation in numbers in the first count is not regarded as significant because there may have been a difference in the holdover of seeds from the 1928 sowing and in the amount of natural seedfall of the previous year. Of course, rodent activity accounts for the much lower germination outside the exclosure and for a good share of the variation between plots in the unprotected series. Since, however, germination was adequate on all the plots, this study concerns itself primarily with survival. Because of the uncertain variable introduced by rodent activity, even after germination, only the rodent-protected plots will be considered in determining the effect of grass cover upon survival.

Abundant rainfall through the fall of 1929 prevented the heavy mortality which sometimes occurs during this season of the first year. Although the counts show a decline of over 50 per cent. on some plots up to November 20, this amount of loss is considered less than normal, in the light of past experience. Activity of a root-cutting insect accounts for some of the deaths but most of them are unexplained. The soil was moist on the surface up to November 20, when observations for the season were discontinued.

Counts on May 29, 1930, revealed large losses on some of the plots. An earlier examination indicated that the loss had occurred during the winter months. Deficient soil moisture could scarcely have been a factor, but absence of snow in December created conditions favourable to winter killing. It was thought in the study of 1919 to 1921 that a cover of any kind would protect young seedlings against winter killing, but these records show that survival was best on the plots having least cover. Although it would be difficult to establish a direct relation between survival and height and density of grass cover, the high survival on the denuded plot and the 2-inch clipping is outstanding.

Another experiment conducted during the same period offers a suggestion. Pine seedlings in the nursery at Fort Valley were grown during the summer of 1929 in full sunlight, half shade, and about 90 per cent. shade. In the spring of 1930 every seedling in 90 per cent. shade was found to be dead. The evidence points to shade during the growing season of 1929 as being the adverse factor. It is to be expected that a plant shaded to the extent of retarding photosynthesis would suffer during a prolonged period of cold weather, because of low cell-sap concentration and deficient food storage. It is conceivable that a stand of grass 2 or 3 feet tall might be effective in bringing about such a condition. From the first season, the seedlings in the tall grass had the slender form of stem and needles characteristic of shade influence. Whatever may be the true explanation, the winter losses as shown by Table 1, were much greater on the plots covered by tall grass than on the denuded plot and the one clipped to 2 inches. The 6 and 10-inch clippings behaved more like the unclipped than the clipped plots. It would appear from these results that the injurious effects

TABLE 1.

RECORD OF GERMINATION AND SURVIVAL OF PONDEROSA PINE SEEDLINGS ON GRASS PLOTS TREATED IN DIFFERENT WAYS

A.—Protected Against Rodents

Plot	Treatment of grass	Density[1] of grass		Number of live seedlings on different dates									Height of seedlings 8/18/33.		
				1929			1930			1931	1932	1933			
		A. f.	Others	Aug. 22	Oct. 25	Nov. 20	May 29	Aug. 6	Oct. 17	May 21	July 18	Aug. 18	Range	6 in. & over	10 in. & over
													Inches	No.	No.
1	Natural ..	·0823	·0033	309	181	151	28	6	6	1	1	1	5	0	0
2	Clipped to 10 in. denuded (1932) ..	·0765	·0277	169	97	91	43	1	1	0	0	0		0	0
3	Burned 1928 ..	·1259	·0376	332	279	271	91	23	17	15	10	8	2—6	1	0
4	Denuded 1928 ..	..	..	382	378	374	288	148	136	109	100	71[3]	5—17	69	29
5	Clipped to 2 in. ..	·1681	·0226	258	224	219	116	30	29	16	11	11	2—10	2	1
6	Clipped to 6 in. ..	·1070	·0083	241	231	218	56	8	9	5	4	4	3—11	2	1
7	Natural ..	·1002	·0032	90	89	81	20	11	8	8	5	5	3—7	1	0

B.—Unprotected Against Rodents

Plot	Treatment of grass	A. f.	Others	Aug. 22	Oct. 25	Nov. 20	May 29	Aug. 6	Oct. 17	May 21	July 18	Aug. 18	Range	6 in. & over	10 in. & over
8	Natural ..	·1050	·0180	79	59	40	4	1	0						
9	Clipped to 10 in. ..	·0866	·0155	81	63	52	3	0							
10	Burned 1928 ..	·0850	·0270	63	53	46	5	0							
11	Denuded 1928 ..	..	..	122	99	97	62	17	15	5	2[2]	2	5—7	1	0
12	Clipped to 2 in. ..	·0895	·0121	138	87	72	25	7	1	1	0				
13	Clipped to 6 in. ..	·0943	·0043	65	55	39	10	4	2	0					
14	Natural ..	·1030	·0062	70	56	37	7	3	2	1	1	1	6	1	0

[1] Density of perennial grasses referred to a complete cover represented by 1. Measurements 1 inch above the ground, June, 1928. **A.** f.—Arizona fescue.

[2] Both seedlings had their tops cut off by rodents in 1931.

[3] 25 seedlings removed in 1932 as a thinning measure.

of shade begin during the first season instead of later as reported in the 1919-21 investigations.

The first serious loss came in the latter part of June and early July, 1930, as recorded in the August count of Table 1. Here again it was the grass plots that suffered most. The effect must be attributed mainly to drought resulting from root competition. Soil moisture determinations were not made in 1930 but they were in 1933, with results as shown in Table 2. The year 1929 had heavier summer rainfall than 1933, but autumn rainfall was similar, being above normal in both years.

A comparison of the seven plots in Table 2 brings out one relationship that is especially significant. At the beginning of the series of soil samplings on June 3, plant growth was just getting well under way; and all the plots had a good supply of moisture, the denuded plot No. 2 being below the average in this respect. As the dry period advanced through June to July 5, the grass-covered plots declined sharply, whereas the denuded plots declined but little, retaining a margin above the highest grass plot of 3·7 per cent. at a depth of 4 to 6 inches and 4·4 per cent. at 6 to 9 inches. Plot No. 4, which had been denuded in 1928, but now bears a dense stand of pine seedlings averaging a foot in height, behaved in essentially the same manner as the grass-covered plots. After the summer rains were well in progress (August 3), the

TABLE 2.

SOIL MOISTURE UNDER DIFFERENT CONDITIONS OF GROUND COVER (SAMPLE PLOT S 3 B, RODENTS EXCLUDED), 1933

Depth of Sample 4 to 6 inches

Plot No.	Treatment of grass	Soil moisture, based on dry weight					
		June 3	June 19	July 5	Aug. 3	Sept. 5	Oct. 20
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1	Natural ..	19·2	9·5	7·7	19·5	12·3	20·8
2	Denuded 1932 ..	14·8	12·4	12·8	16·8	16·7	21·7
3	Natural (burned 1928) ..	15·9	10·2	7·4	20·1	12·4	21·4
4	Denuded 1928 Dense stand of pine seedlings 1933 ..	16·1	11·6	8·8	13·2	11·8	17·1
5	Clipped to 2 in. ..	16·8	9·5	6·2	19·1	17·0	21·1
6	Clipped to 6 in. ..	13·7	10·2	7·1	23·0	15·6	21·9
7	Natural ..	17·7	13·3	9·1	23·2	21·1	22·6

Depth of Sample 6 to 9 inches

Plot No.	Treatment of grass	June 3	June 19	July 5	Aug. 3	Sept. 5	Oct. 20
1	Natural ..	19·1	10·3	8·3	18·1	12·6	18·4
2	Denuded 1932 ..	15·0	12·7	13·5	23·5	17·8	20·9
3	Natural (burned 1928) ..	16·4	9·2	8·4	18·6	13·5	19·9
4	Denuded 1928 Dense stand of pine seedlings 1933 ..	17·5	11·1	10·8	13·8	12·0	17·0
5	Clipped to 2 in. ..	22·4	10·3	7·7	19·3	17·5	19·9
6	Clipped to 6 in. ..	17·0	10·8	8·1	23·9	16·8	21·5
7	Natural ..	19·3	13·7	9·1	21·3	17·4	21·1

grass plots replaced their earlier water loss, all surpassing the denuded plot at the 4 to 6-inch depth. Plot No. 4, bearing the large 1929 pine seedlings, lagged behind the average of the grassy plots after July 5, indicating that the pine seedlings were consuming more water than the grasses. Throughout the entire growing season, the graph of the denuded plot No. 2 maintained a more even course than the graphs of plots bearing vegetation, whether grass or young pines. Its high position at the critical point on July 5 is especially significant, and explains why plot No. 4, denuded in 1928 lost so few pine seedlings in the dry season of 1930, as compared with the grassy plots.

A full explanation of all moisture changes and relations between plots throughout the season would add unduly to the length of this paper ; but it is desirable to point out the major factors involved. The dependence of soil moisture upon rainfall is self-evident. Evaporation is also important, though less far reaching than rainfall. Evaporation is rapid at the soil surface, but it decreases toward the lower levels, and virtually disappears at a depth of one foot. After the upper layer to a depth of several inches becomes air dry, further loss from this layer ceases until the supply is replenished by rainfall or otherwise. A mulch of dead litter or the shelter of vegetation retards the rate of evaporation. This explains, in part at least, the higher moisture content of the plant-covered plots than of the denuded plot on June 5. Finally, it should be understood that soil moisture determinations are not an accurate measure of the moisture content of the whole plot. Each sample represents only the particular spot on which it is taken, and the result may be different a foot distant. This element of error may account for minor fluctuations within a range of perhaps 2 per cent. Wilting coefficients have not been determined for this series ; on a similar site nearby, determinations in 1920 gave values ranging from 9·8 to 10·7 at a depth of 9 inches.

Next to precipitation, the dominant factor affecting soil moisture is water consumption by plants. This overshadows all other factors in the relation between various plots of the present study. Direct evaporation from the soil is distinctly secondary, especially when soil layers a few inches beneath the surface are concerned. During the rainy period, extending from August to October, 1933, the denuded plot No. 2 was consistently lower than the grassy plots at a depth of 4 to 6 inches. The difference is due in large part to higher evaporation on the denuded plot ; penetration may also have been less on the bare soil, due to more rapid runoff. Had samples been taken nearer the surface, the difference in favour of the grass-covered plots would have been still greater, as indicated by the observations that the top soil on these plots remained almost continuously wet, whereas the denuded soil dried off between showers. At a depth of 6 to 9 inches, however, the denuded plot was well up to the average of plots covered by grass, indicating that at this level evaporation had less influence than absorption by plant roots.

Clipping did not accomplish the saving in water consumption that might be expected from a reduction of leaf surface. Several factors combined to offset any favourable transpiration balance. In the first place, the grasses were clipped only once in the early summer, and thus there was an appreciable amount of green leaf surface during the dry period. According to Table 1, plot 5, clipped to 2 inches,

had a greater grass density than any of the natural plots. The clipped plots were more exposed to evaporation than those covered by tall grass. Although all of the plots have a density below 0·2 as measured at the ground line, the spreading stems and leaves create almost a complete canopy save for occasional relatively large openings. Finally, and this may have been an important factor, the spaces between grass tufts on the clipped plots were invaded by a rather dense stand of spring annuals, mostly too low to be affected by clipping. They were removed from the denuded plot but not from the others ; on the natural plots they were little in evidence. All of these factors presumably operated in much the same way in 1930, and this explains why the June-July mortality of that year was practically as high on the clipped as on the natural plots.

A record of numbers and heights of seedlings on the various plots is given in Table 1. In the final checkup, the superiority of the denuded plot in both numbers and size is convincing. The 2-inch clipping, though far behind the denuded plot, holds a distinct lead over the unclipped plots. The 6-inch clipping is low in numbers, but it ranks with the 2-inch clipping in size of seedlings. No explanation can be offered for the complete failure in 1930 of the plot clipped to 10 inches. Only one seedling on the three plots bearing tall grass measured up to 6 inches in 1933 ; none attained the 10-inch mark ; and all showed the effects of shading.

A glance at the record of the plots open to rodents (Table 1) leaves little doubt as to the dominating influence of this factor. It should be borne in mind, however, that protection against grazing and predators has built up an abnormal population of meadow mice, and that the damage by these animals was undoubtedly greater than would be experienced in an area open to grazing. The damage was not confined to eating seeds, but went to the extent of biting off the tops of seedlings up to their third year. As late as August 6, 1930, after the close of the drought period of that year, survival on the various open plots was in complete accord with the relationship found within the rodent enclosure. Between this date and May 21, 1931, rodent damage was the major factor and it reduced the number of seedlings so greatly as to render the plots valueless for comparison of losses due to plant competition. The two seedlings in the denuded plot No. 11 were both injured by rodents in 1931. The lone survivor in all of the grass-covered plots outside the rodent exclosure is in an open space 18 inches in diameter.

In 1932 all the plots except No. 4, which was already fully stocked, were resown. Plot 2 was also denuded in the same manner as No. 4 had been in 1928. It developed that the rodent exclosure was no longer rodent-proof because the seeds were eaten by rodents, as evidenced by the broken seed coats which littered the ground a week after seeding. Not one seedling was obtained. Needless to say, the same result was experienced outside the exclosure, except on a denuded space of about 2×4 feet which was covered by a special screen. This plot supported 84 seedlings in October, 1932 ; on January 3, 1933, there were 65 ; and on September 4, 51 remained. Another plot near by treated in the same manner contained 75 seedlings in October, 1932, and 32 on June 3, 1933. The screen was removed on July 5, at which time 24 live seedlings were counted. On September 4 every seedling was found to have been injured

by rodents; 19 were reduced to mere stems, and only five retained any leaves. In July, 1933, a similar denuded plot was resown and screened; on August 18 it contained 60 seedlings. The results clearly show that on good soils little or no shade is needed to obtain germination, and also that small rodents may destroy seedlings a year old.

The foregoing findings are entirely in accord with experience in nursery practice in this region. Ponderosa pine seed beds are usually shaded in order to maintain the uniform surface moisture required to insure complete germination; but in normal rainy seasons satisfactory germination is obtained without shade. It has been demonstrated time and again that if shades are left on ponderosa pine beds through the second season, the seedlings develop a slender and weak form. No experienced nurseryman allows weeds to grow in seed beds, for he knows that if this takes place the seedlings are going to suffer. The findings are also in accord with long established practice in European forests where precautions are always taken to avoid the suppression of young conifers by dominating herbs and shrubs.

Interpretation of Results.

Although the findings which have been presented are conclusive for the conditions described, they should be interpreted with full knowledge of other conditions which may be encountered. They establish a principle rather than a rule. Not all grasses grow so rank as to interfere seriously with pine production and not all soils will produce a tall, dense stand of grass. On the other hand, the richer soils, such as those found in stump patches, may bear weed growth capable of offering more competition than the most luxuriant grasses. The facts to be remembered are that ponderosa pine is intolerant of shade; that it does not need shelter in the form of overhead cover, even in the seedling stage; and that it needs a fairly sustained though not abundant moisture supply during the first few years of its life. Competing vegetation, if tall enough to overtop the seedlings, can easily produce too much shade; and plant growth of any kind competes for moisture. A limited amount of vegetation, though drawing water out of the soil, also aids in absorption of rainfall, and retards evaporation. It, therefore, becomes a question of preserving a favourable balance rather than complete removal of competition. How much ground vegetation, if any, is required to preserve this balance depends upon soil and topography. In the experiment here described, the soil has a high clay content; but it has been mellowed by 18 years' accumulation of organic matter, under complete protection from grazing. Similar conditions are found in greater degree on stump patches where leaf litter has rotted down for centuries. On such sites, if the soil is held in place, pine seedlings attain their maximum growth where competing vegetation is entirely eliminated. This also applies to sandy soils or other soils which absorb moisture readily and do not pack under grazing use or under the impact of rainfall. Whatever herbaceous vegetation may be needed on soils of this class is to hold them in place and retard runoff until a stand of seedlings can obtain a foothold. In fact, it is not essential from the standpoint of pine reproduction that the soil have a high degree of stability, so long as it is deep and permeable, because ponderosa pine is a veritable weed which, under favourable conditions of climate and seed supply, takes possession of sites too sterile to support grass.

Whether herbaceous vegetation is detrimental, neutral or favourable to pine reproduction depends on its density and habits of growth, and upon the character of the soil. On this basis, the more common species or plant associations in the region of this study may be classified as follows:

Arizona fescue (*Festuca arizonica*).—This grass, where dominant, is distinctly unfavourable because it attains a height of from 24 to 30 inches, forms a dense ground cover, is active during the June and early July drought period, and under conservative stocking is more lightly grazed than most other forage plants. It attains its best development on soils that are rather too heavy for the best development of pine seedlings in the early stages. It should be heavily grazed, or removed by mechanical means in patches, to permit establishment of pine seedlings.

Mountain muhlenbergia (*Muhlenbergia montana*).—Though normally growing almost as tall as Arizona fescue, this grass is usually less dense, is more closely grazed, and thus creates less shade than the fescue. It remains practically dormant through the June-July drought period, thus tending to retard evaporation without competing seriously for moisture during this critical period. It commonly occurs on stony or gravelly soils that are naturally favourable to pine seedlings. If not too dense, it is favourable or at least neutral toward pine reproduction.

Blue grama (*Boutelouagracilis*). –Ponderosa pine usually reproduces well on blue grama sites within the pine type. This grass is relatively short, makes little or no growth before the summer rains, and is grazed in preference to most other species. It therefore offers a minimum of competition for light and moisture, while providing a desirable soil cover on heavy soils.

Black sporobolus (*Sporobolus interruptus*).—This grass is commonly found on clay soils on which pine seedlings normally become established with great difficulty. It is short, except for the scattering flower stalks; because of its high palatability, it is cropped close to the ground wherever livestock graze; but it is one of the earliest grasses, and therefore competes for soil moisture during the early summer dry period. On the whole, its favorable influence probably outweighs any ill-effects of root competition, because a cover is almost indispensable on the heavy soils which it frequents.

Mixed weeds.—The weed growth which commonly succeeds grasses on overgrazed lands is for the most part beneficial to pine reproductions, because it seldom becomes tall and dense, and it provides more or less cover needed to hold the soil and retard runoff. On rich soils, such as occur on stump patches, however, weeds, if not closely grazed, often become so luxuriant as to suppress all pine seedlings.

APPLICATION IN GRAZING PRACTICE.

Control of herbaceous vegetation in the Southwest is necessarily associated with grazing. Grazing to the point of near denudation is, under most conditions, undesirable because it tends to pack and otherwise deteriorate the soil. Grazing Arizona fescue down to a height of 2 inches will not bring results equal to those of mechanical denudation, but it will aid materially, especially where the density is low and where

spring annuals are eaten close to the ground. Grazing of such intensity over a long period is admittedly not good for a bunch grass range, but it is not necessary nor desirable from a forestry standpoint to continue heavy grazing indefinitely. A better course is to graze conservatively, as a regular practice, until a good cone crop comes into evidence, then increase the intensity only for such time as required to save the seedlings from suppression. With a good seed crop in prospect, bunch grass areas of deficient reproduction should be grazed heavily, preferably by cattle. Where Arizona fescue is not present to any great extent, the grazing can be more moderate, but all vegetation should be grazed to such a degree that it will not form a dense and deep cover over continuous areas. Seedlings already present are likely to be injured under such treatment, but those over 2 years old can endure considerable browsing for a few years without serious consequences. Heavy grazing through the summer and early autumn in the year of seed development will discourage propagation of mice and will expose the ground for the reception of seed. (Poisoning of small rodents is to be recommended in this stage.) The same beneficial effects will be realized from heavy grazing continued through the second year. Germination seldom takes place before the summer rains. In about two years out of three, the rains will be found adequate for germination. If a good stand of seedlings is obtained, grazing should be directed toward encouraging their survival. Unless extreme overgrazing is practised, few seedlings will be damaged the first year because stock do not habitually browse them in this stage. The second season, however, is critical, and damage should be held to a minimum because seedlings severely browsed at this age are more than likely to die. After their second year, pine seedlings withstand considerable browsing, and, within reasonable limits, the permanent loss from browsing is less than that resulting from unrestricted grass competition. By the time the seedlings are five or six years old, they should have developed both roots and crowns that will enable them to compete successfully with grasses. Grazing should then be reduced or otherwise so regulated as to practically eliminate the browsing of terminals. Substantial height growth will follow and soon the seedlings will take their place in the sun.

Essentially the foregoing practice has been applied with gratifying results. In the Fort Valley experimental forest goodly numbers of 1928 and 1929 seedlings have become established under heavy cattle grazing followed by lighter grazing. It was the method unconsciously and crudely practised on the Coconino and Tusayan in the years when the now famous 1919 stand of seedlings came into being. Failure on many areas to reduce the intensity of grazing at the right time prevented full realization of this rare opportunity to obtain complete stocking.

A program such as here outlined will encounter objection on the ground that the range livestock industry cannot adjust itself to sudden fluctuations in the size of its herds. My plan does not contemplate violent changes in numbers over a whole national forest or other large unit, but a shifting of stock from one area to another in accordance with the requirements given above. The plan calls for conservative stocking of the forest range as a whole, and it calls for government control of water and other range improvements. In view of the fact that only relatively small areas need be involved at any one time, the administrative difficulties would not be unsur-

mountable. No doubt, some inconvenience and increased expense to grazing interests would be entailed, but this is justified and must be expected on lands whose chief value lies in timber production. Incidentally, it is well to bear in mind that on pine sites, accessible to market, and managed primarily for timber production, the annual timber increment has a stumpage value of 15 to 25 cents an acre, whereas the forage crop on the same area brings only about 1½ cents an acre. In a large proportion of the ponderosa pine type in the Southwest, grazing receipts by the Forest Service fall below the cost of administration and range improvements provided by the government. During the next two decades an advancing tide of pine thickets will force millions of additional acres into this class. The time is not far distant when an economic livestock industry cannot exist on well managed timber lands unless the needed range administration and improvements are furnished by the government at much less than actual cost. A certain amount of grazing in the forests is desirable for various reasons, such as fire protection, silvicultural benefits, and the support of local industry; but, if the government must pay out money to have its forests grazed, it should direct this grazing along a course that will be most useful to the forest.

I am not advocating a return to the old practice of continuous overgrazing; on the contrary, I believe that as a general thing the forest ranges, as well as other ranges in the Southwest, are still too heavily grazed. Pine seedlings are still being damaged too much in many places. After a forest has become well restocked, light and well distributed grazing is the proper course. During the reproductive stage, however, there are times for heavy as well as light grazing. On national forest lands whose primary crop is timber, grazing should be regarded as a part of silviculture; its main object should be silvicultural, and if the cost of carrying on grazing exceeds grazing revenue, the excess should be subject to silvicultural justification. (*Journal of Forestry*, May 1934.)

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AN EXPEDITION INTO SIKKIM.

BY F. C. OSMASTON, I.F.S.

PART II.

(*Continued from pages* 424-34 *of July Issue.*)

On the 13th October we moved to our real Base Camp, only 2 miles away to the south-east, and 16,500 ft. high. It lay on the shores of a lake, at the base of the Fluted Peak glacier. It was a dry site, free from snow, sheltered from the north by old moraine and hill-side. Moraine and scree mountain side on the southern side of the lake also sheltered us, so that views were not wonderful except for the Fluted Peak that rose in forbidding beauty above us to the south-west, blotting out the higher mountains behind. While our porters were changing our camp we and our "sirdar" or leader and subordinate in charge of our porters, examined the way up the Fluted Peak glacier and the route to our next camp from which we should attack the peak. We skirted the lake along flat grassland and then mounted the moraine that bordered a second smaller lake fed by the very snout of the glacier. At first this was easy-going, but it soon became very steep and though easy enough to climb (even to me) was naturally laborious. In only one place was there any difficulty and only because the moraine was very loose and by no means stable. It easily slid to fall a couple of hundred feet on to the snout of the glacier below. Here we made a rough path for our porters and ourselves to traverse the next day.

We then edged on to the glacier itself, skirting up along it for some hundreds of feet until it became a little less steep when we began to strike across its face aiming towards the site we had provisionally selected for our camp by binoculars from below. Although we had to cut a few steps in the hard snow or ice with our ice axes (a performance which pleased me immensely because of its novelty and in spite of the surprising arduousness of this simple job, at which

I found I was astonishingly inept and slow compared with the expert strokes of our sirdar). But we did not go very far. We soon came upon crevasses and had to tread our way between them. These were the first crevasses I had ever seen and I peered down them gazing with interest (not to say awe) at their blue green depths that dropped for perhaps 50 ft. or more. We did not go far among these crevasses as we had no rope, and to go unroped was unwise as we were not experienced and could not be certain if we were crossing a crevasse by a thin and unsafe snow bridge.

The next morning we sorted out what was essential for one day, reducing everything to a minimum so that it could be carried by 8 porters. Four of these porters would remain with us for the night and accompany us on the actual attack on the peak. We took three Meade tents, two for ourselves and one for the 4 porters. (A Meade tent has a single fly, has poles about 5 ft. high, is about 7 ft. long and about 5 ft. broad; so two men can comfortably sleep side by side. But movements, such as dressing, are definitely cramped as can be imagined.) Clothing and bedding had to be taken and food for a day and a bit, namely for lunch, dinner, breakfast, lunch, as we hoped to be back at our base camp the next night—an optimistic forecast.

We were off at 9-15 and steadily trudged up the route of the day before. When we reached the crevasses we roped up (another thrill of novelty for me). Nirsang, the sirdar, Latimer and I (in that order) led the way. Much of the first half of the glacier was very easy-going. The snow was crisp and hard, gently sloping and with few crevasses. It then got much steeper and Nirsang had to cut steps in places so that our progress though steady was slower. We then reached the "bergschrund," *i.e.*, the more uneven beginning of the glacier where snow accumulates from avalanches down the main mountain face. Here we began to cut across the glacier more or less on one contour, until we reached our camp site. We pitched camp, which meant shovelling a good deal of snow to make flat foundations for our tent. The slope of the glacier was about 30°, so that everything loose rolled uncontrollably down the glacier to

A view of the "Glacier Camp" (18,500′).

A view of Kanchenjunga from some 10 miles from its foot looking west up the Zemu glacier.

fall into crevasses hundreds of feet below. We then had lunch and four of our porters and Nirsang returned to the Base Camp.

For the remainder of the day I quote from my diary :—

" At about 1-30 Gordon and Latimer started to climb up to the ridge behind us and along which we shall climb to the peak to-morrow. They went along steadily and got to the ridge at 3-0 P.M. Meanwhile, I stayed behind and, as the camp was in shade from 1-30 P.M., got into warmer clothes and then helped our servants to burn the two Primus stoves and make tea.

The view from here is grand, especially as it is the clearest day we have had. On the extreme left (north-west) one of the Dodang-Nyima peaks is just visible, then comes the Choten Nyima and the La into Thibet, next to which stands the Sentinel Peak, from which spread a range of unnamed peaks each 20,000 ft. or considerably more forming the Dodang-Nyima range which merges into the Koryada range further east, reaching to Chomiomo and Kanchenjau peaks. Chimal Hari is, however, just hidden by a spur of the Fluted Peak, having been clearly visible on our way up.

Gordon and Latimer got back at about 3-45 and we all had some hot tea. After they had changed or rather added more clothes, we had dinner brought to us sitting in our Meade tents by our admirable servants. We had hot barley soup, hot meat and vegetable rations (on *warmed* plates) and warmed tin apricots with brown Firpo's bread (2 weeks old) and Ryvita. Prunes and sweets for dessert and later, hot Ovaltine. Our orderlies did every thing on two Primus stoves which worked well.

The view during dinner was magnificent. Perched in our eyrie we see sunlit, snow covered mountains, nearly all over 20,000 ft., with deep shadows that contrast vividly with the whiteness of the snow, while light grey clouds caress them lovingly at 17,000 ft. to 18,000 ft. The dark brown, dry and rocky Lhonak valleys lie asleep beneath. As a foreground the Fluted Peak glacier rolls its white mass, darkened by grey crevasses down to the quiet lakes 2,000 ft, below.

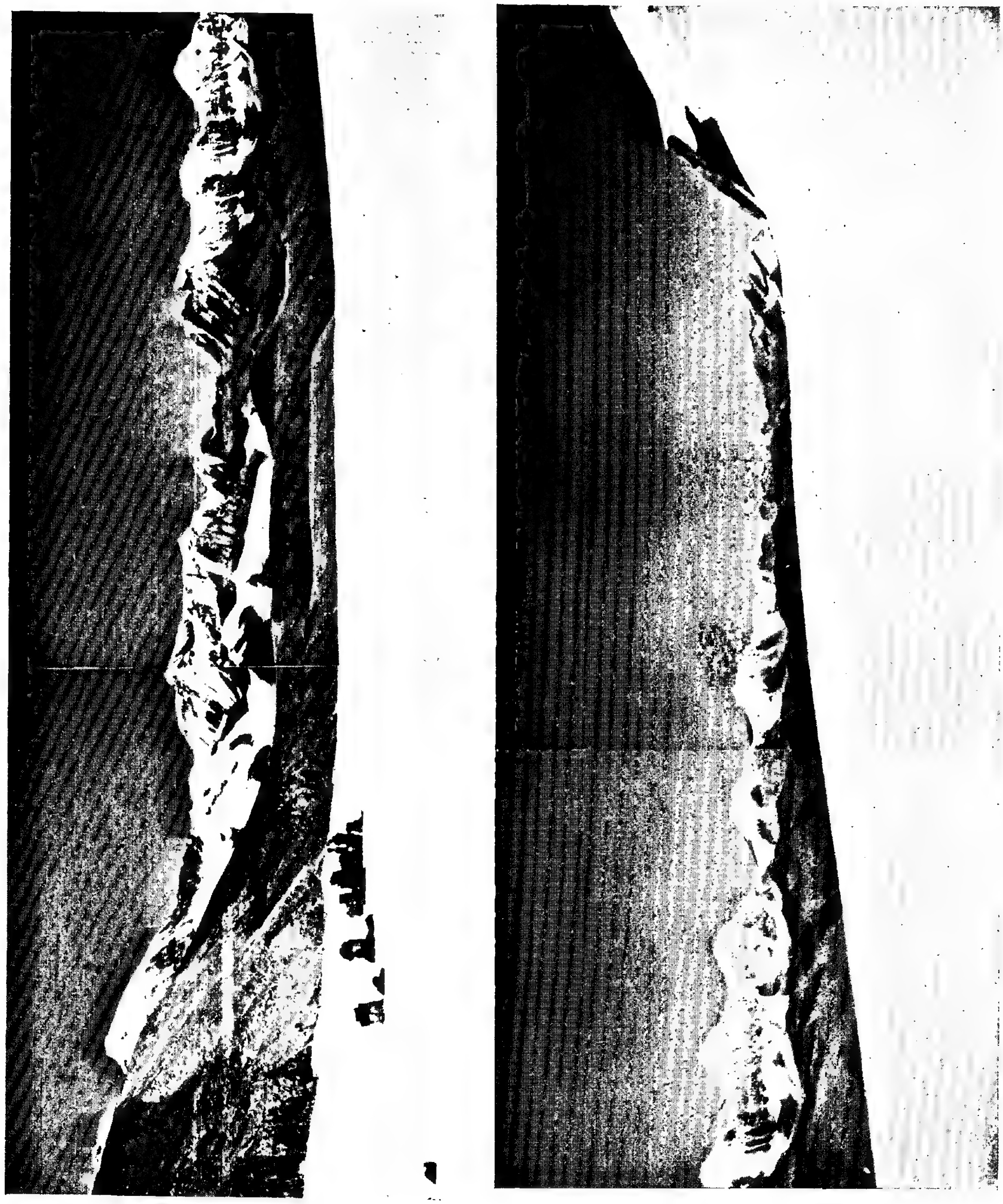
After Ovaltine at about 5-30 or so, we retired to bed, all pleased at having reached about 18,500 ft., a record for each of us. For the first time so far I did not get into pyjamas!"

(*Note.*—Air temperatures at glacier camp were as follows: At 3-30 P.M. 25° F., at 5-45 P.M. 18° F. and 6-00 A.M. (on the 15th) 14° F. We did not take any minimum reading.)

None of us slept well that night. I found it difficult to keep warm. In spite of wearing a Balaclava, a thick vest, shirt and (for the latter part of the night) a woollen pullover, long pants and warm socks, I was never really warm although my sleeping bag was of eiderdown and an excellent one. I think I was cold because of cold coming up from the glacier snow below, through hold-all, sorbo rubber sheet and all. Besides I was not used to sleeping on a glacier and had not realised that a glacier is never still, never quiet. It keeps on murmuring and though you cannot really feel it move, the far away shudders and slips that are always going on are communicated to you. So it feels as if it might, at any time, begin to disintegrate, though you know perfectly well it will not.

We were up at 6-0 A.M. and, after a breakfast of hot tea, biscuits, bread and bully beef, set off to attack the peak. We started at 7-15 and were roped in 3 parties. My cousin, myself and my porter-servant on one rope, Latimer, Stobart and another porter on the second rope, and two porters on the third, in that order. I cannot say that I really enjoyed the day (except perhaps coming down). Nor did I cover myself with any glory (but rather the reverse) though I succeeded in demonstrating my "greenness" as a mountaineer and, I fear, lack of the ability ever to become one. However it is a good day to remember, nevertheless!

Our first job was to reach the rocky arréte some 400 ft. immediately above our camp. To reach it we had to traverse a rocky couloir, lying at an angle of about 45°. This was not difficult, being rocky and not too steep. The only danger was that the leaders could not help dislodging some of the numerous loose stones and rocks that littered the couloir. To do this caused other rocks to move and endanger those below. So we climbed as close together as possible,



A panoramic view looking north from the Podon La (19,500') towards the Dodang Nyima and Koryada Ranges that are the boundary of Tibet.

and reached the rocky arréte that led to the top in an hour. Here we had a short rest.

The ridge to the top was mainly made of rocks of varying sizes and solidity, varying from those the size of one's head to those 10 ft. to 15 ft. high. Some were parts of the mountain, but many were lying loose. The width of the ridge varied from 3 ft. (except where there was snow where it might be 1 ft. to 2 ft.) to 30 ft., the average being, say 15 ft. There was a large drop on either side, being steepest on the south where it was often perpendicular. The depth of this drop increased as we climbed, being, say 2,000 ft. at the top.

As I have mentioned, I cannot say that I enjoyed this climb. It was my first real climb, and though it was not really difficult but only laborious, nor perhaps even dangerous except in one or two places (where there were snow patches), the huge drops on either side made me feel uncomfortable. The looseness and narrowness of the ridge (especially as evidences of slips were numerous) made me think that the ridge itself might give way—more disastrous than if one slipped oneself. The 2 or 3 snow patches were the worst as they were always at the steepest and narrowest places of the ridge. We had to traverse these snow patches very carefully. The leader went on alone cutting steps, the others anchoring themselves in position and paying out rope as the leader went on. The second man followed in his footsteps when the leader was across or had secured himself, and so on.

However, we went along steadily, though I fear that I should not have got far if it had not been for the exertions of my cousin in helping me over the worst places. But finally at about 1-0, when we were about 500 ft. below the top, I decided to give in. I was feeling pretty well exhausted, due no doubt largely to my inexperience in the work and thereby using strength in the wrong way. Moreover the worst part had yet to come. I would anyhow hinder the others and somehow my enthusiasm to reach the top had largely evaporated. Even an elevation of only 20,000 ft. seems to sap one's ambitions and energies to an astonishing degree.

So I halted and the others went on, disappearing from sight.

I had some lunch and waited. I waited for a long time and by 3-0 P.M. I began to get very cold as the sun had gone round and I was in shadow. So I moved down a bit. This was the worst part of the day as far as I was concerned. To get into the sun I had to negotiate a piece of snow only about 12 yards long but with a drop of say 2,000 ft. almost vertical below. It was not a question of going along a ridge, but along one side of this snow patch. The snow was lying at an angle of about 70°, I should say, the drop of course being immediately below. Steps had been already cut when we came up. I went across first, telling my porter-orderly to anchor himself and pay out rope as I went. He seemed incapable of doing this. He either could not understand my orders or, having been on 2 Everest expeditions and some others, treated the whole affair as a mere stroll. When I was half-away across I looked back to see him paying very little attention to the whole business! This did not increase my confidence or reduce my clumsiness in crossing the snow. (Why is it that steps cut by some one else *always* seem too far apart ?)

Well, of course, I did get across in the end and then anchored myself firmly and my orderly crossed. I was still far from confident of remaining alive, as I did not feel certain that I could hold my orderly if he slipped and fell. However he didn't, but came slowly and confidently across.

This, together with being in the sun again cheered me up. But I was now anxious about the rest of the party. It was past 3-0 and there were no signs of them. Had something happened ? Should I go and see ? What an awful thought ! This would mean recrossing that snow again, and what could I do if they had fallen over the edge further on ? Very little, except go down the hill and look for their remains the next day. (Even then I would not know which side to look !)

Fortunately these difficulties were solved by hearing them at 3-30, but it was not till 4-0 that they reached me. Unfortunately they too had failed to reach the top. They reached a point about 200 yards from the top and 200 ft. below it. They were defeated by the last stretch of snow along a knife-edge. This would have

been possible, but for its extreme softness. At each step they sunk in up to their knees, and it was difficult to know which side of the ridge they were putting their feet. (Very nasty, I was glad I was not there !) My cousin thought it might have been *just* possible to negotiate. But anyhow there was no time.

So back we went, roped in two parties this time. Our progress was steady but slow and we did not get back to our camp until after dark, by moonlight, at 6-30 P.M. There was only one real excitement and that was when the last man in the party dislodged a rock on the rocky couloir. The rock was a big one, but it thundered harmlessly past us. The last part was a little tricky in the dark as there was a crevasse at the foot of the rocky slope to traverse, but it seemed easy after what we had done.

We decided not to go back to our base camp but stay at Glacier Camp for the night. To go on would not only be most tiring, but difficult for our porters in the dark. So we got the Primus stoves going and our orderlies cooked us some tea, and after that we munched biscuits, chocolate, bread and honey (there was nothing else). And so to bed, all fairly exhausted. We had failed to reach the top. But we had all reached 20,000 ft. as we thought (actually the readings taken by my cousin showed afterwards that the Fluted Peak is only 19,750 ft. and not 20,750 ft. as shown on the map). Moreover, we had accomplished a long hard climb not previously attempted and we (or rather the others) had only been beaten by time and an impossible 200 yards of snow. Besides we were all alive, a matter which surprised me not a little.

To reach our Base Camp the next morning seemed child's play even without a breakfast except for tea. We rattled down the hill to have a good hot breakfast at 9-30 in our Base Camp which now seemed the height of luxury and comfort. For the remainder of the day we rested except for my indefatigable cousin who went off to collect more survey data with his plane table.

On the 17th, our party began to break up. Stobart, though fit, had to return to Calcutta as his leave was nearly up. Latimer went with him. He had been troubled for some days with tender bleeding

gums that were getting worse and going black. All very strange, and rotten for him. So he was wise to return. My cousin and I stayed on for another day to return by a longer route. I rather envied Latimer and Stobart returning, as I was not feeling too fit. My knee was paining me and an odd persistent pain had begun to attack me in the pit of my stomach.

So when the others set off back, my cousin and I started to march to the Choten Nyima La about 6 miles off leading into Thibet. I regret to say I did not get there either, though my cousin did. The pain in my tummy got worse and sapped all my energy. And it is surprising how a persistent tummy ache does sap energy. So I came back after lunch, from the foot of the slope to the La. I was very tired when I arrived but slowly recovered. My cousin got back very late (after I had sent out men with lamps) at about 8-0 p.m. Very tired too. But he had climbed up to the La and seen into Thibet and verified that the position of the Sentinel Peak as shown on the Survey of India map is correct and that it is not in Thibet as shown on the German map. The last part of the pass is steep, about 800 ft. in height and composed of sliding scree. How yaks can cross this La, as they are reputed to do, is a mystery unless a special path is made for them each time.

The next day, the 18th October, we too started back. That day's march was uneventful though it took us a long time. We camped about 8 miles away, more or less due south under the Podon La at 17,600 ft., the Tent Peak being to our immediate east. But the next day during which we climbed over the Podon La (19,500 ft.) was a grand day. My diary will again, I think, describe it well enough :—

19*th October* 1932. Podon La Camp (17,600 ft.) to Green Lake glacier camp. Distance about 4 miles. Rise about 2,000 ft. to the La and then a fall of about 2,500 ft.

A very strenuous and interesting day. We left camp at about 8-0, the day being perfect. We went slowly up the moraine on the glacier's west bank, taking survey readings and photos on the way. We left the moraine and went on to the glacier at about 10-30,

Gordon, I and Ondju roped together, the rest following in our tracks unroped. We went slowly up over in easy slope, the snow being good with no crevasses. At 11-35 we stopped some 400 yards from the La for photos and survey readings, finally reaching the La a little after noon, Kanchenjunga and the Tent Peak filling the sky in front of us. More Survey and Photos. (*Note*.—It is interesting that my diary makes no remarks on the magnificent views we had from this La. To the north there was a wonderful panorama of peaks stretching right round the horizon. Then to the south-west Kanchenjunga and Tent Peak towered above us in majestic grandeur— a never-to-be-forgotten sight. But we had daily seen so many wonderful views that I began to stop mentioning them in my diary.)

"We then all roped together in 3 or 4 parties for the descent down the Green Lake glacier, whose head spread in a huge white snowfield before us, turning left-handed to pour through the Zemu Gap opposite Tent Peak. The going was easy and the snow good so we made good progress at first until, half an hour later, crevasses become not only more and more frequent but larger, so that our route became tenuous as we picked our way between them. At first we had kept more or less to the middle of the glacier but now we edged to the left (east), hoping to go more easily down moraine. But no moraine appeared. So we had to pick our way round crevasses, down, along, up and across crevasses, slowly and tediously, often under huge ice cliffs on the bank of the glacier. Interesting, but very hot work.

But the fall became steeper and the glacier became more and more jumbled and cut up as it crammed itself into the Zemu Gap. It became impassable, so our only alternative was to climb along its very steep-sided and loose rocky edge and then down a couloir in the rock face but away from, or rather parallel to, the glacier. This couloir was not narrow (and so not a "chimney") but was steep for 600 ft., the average angle being about 50° and for the top 150 ft. about 60°. Moreover the couloir was covered with loose stones and scree which shot down to the bottom alarmingly when disturbed. For the first 150 ft. each man had to go down separately by rope. Gordon

nobly anchored himself on the loose knife-edge ridge with the rope bound round him. About 90 ft. down from this ridge was a slight second ridge and a vertical drop of 12 ft. Here two more men were stationed to hold the rope for the last 60 ft., at the bottom of which our sirdar, Nirsang, was stationed to help if necessary. Here fortunately there was a ledge large enough to hold 20 men and shielded by a rock that deflected the flying stones disturbed by each man while he was descending. These stones shot by like canon balls.

We and baggage all got down successfully after about 1½ hour's work (about 18 loaded porters). Only a few apples, a bucket and the cook's stick were lost, shooting down to the bottom of the couloir. Gordon, as last man, managed to climb down without a rope being helped by the 2 men at the vertical drop in the middle.

It was now 4-15 p.m. Fortunately we were able to negotiate the last part without a rope. It was still steep (50°) and covered with loose scree in most places. To overcome the danger of falling stones, we went down bunched together, so that stones dislodged by one man were stopped by the next man before gathering speed. The system worked excellently and by 5-15 we were down without casualties.

The sun was now setting. We were faced by an apparently endless sea of moraine and glacier crevasses. It was obviously passable but would be slow, tedious work and night was at hand. On we went steadily down, making remarkably good progress. But at 6-15 we could see no camping ground and it was nearly dark. We were in a jumble of large moraine rocks. We could have camped there, uncomfortably, but there was no water. We heard some water flowing to our right and decided to go down to it and camp there if we could. Down we went and came upon the glacier again, 100 ft. below. It was practically dark except for a faint light behind Tent Peak, but the place could hardly have suited us better (in that country). The ice was not very jumbled nor too sloping, and would serve for the porters lying on tents and the like. There was a large flat rock, hardly slopping at all on which our porters actually managed to pitch a Meade tent for Gordon and me, and we were as

warm and comfortable there as one could wish. We managed to get both Primus stoves going, drank hot tea and some rum and ate cold bully beef, bread and biscuits—very acceptable as we'd missed our lunch except for some chocolate and sweets. The men had tea, rum and *champa* (barley meal).

So we had managed this difficult pass of 19,500 ft. being, we believed, probably the first Englishmen and the second European party to cross it. (Two Germans in 1931 and 6 porters are reputed to be the only ones to have crossed it, though Kellas may have done so and I'm not quite sure that Shebbeare has not also.) So we went to bed contented and warm, but tired."

I shall not go into many details of our subsequent marches returning to Gangtok. The next day we soon joined the Zemu glacier and marched down it following the route of the German (1930 and 1931) Kanchenjunga expeditions, each march getting easier and easier as we descended. The views of that queen of mountains, Kanchenjunga, were superb. We could easily make out the route followed by the two expeditions and could see what colossal difficulties they had to face and surmount, and we marvelled that they had reached as high a point as they did. We halted one night at their old Base Camp, the remains of the mud and stone wall being still clear and only half demolished.

The next day Gordon and I separated at Yaktang. He was determined to go back by a more circuitous route and visit the Tubeng monastery *via* the Yumtsa La (17,000 ft. or more). I had originally meant to do this, too, but felt far from fit. My left knee was getting worse and paining me at every step. My tummy ache too was no better and was a constant pain that sapped my energy. (In fact this odd pain did not leave me entirely for some 10 days after I reached Calcutta, though my appetite was unaffected.) So we separated and I went back *via* Lachen and the Tista Valley and he *via* the Tubeng monastery, joining me on the 24th evening at Dikchu. He had a tiring journey and was suspected at the monastery, where he arrived after dark, of being a dacoit and had a block of wood thrown on to his head. My journey was easier, and although making

longer marches than on our outward trip and in spite of my knee, found myself regaining my energy. It is extraordinary how lower altitudes restore your energy. Coming up the Tista we did only 12 miles a day. Coming back I did 18, and these seemed comparatively easy though at 17,000 ft., 10 miles was an arduous day. This, of course, is partly explained by the easy track and reduced gradients. The rough hill road up the Tista Valley now seemed to be a high-way indeed and the world fully populated.

And so we arrived at Gangtok together on the 25th where we spent the night. Our first interest was to get shaved. What a luxury it was to shave off 3 weeks of beard! What a joy to feel clean again! Cigarettes I had almost forgotten how to enjoy (though I had had one or two a day) but soon rediscovered their and a pipe's charm. Beer, too, we had promised ourselves and got at Gangtok. Poor though the brand was, it, too, was not the least of the pleasures of our return to civilization. Packets of letters and newspapers greeted us and we slowly regained a knowledge of the world's affairs (though we had not in the least missed the daily tale of events it was pleasant to feel among them again).

On the 26th we were up at 6-30 as usual and were busy for the last time in sorting and repacking kit until 10-45. Any expedition however small seems to be occupied very largely with the tedious but essential duties of sorting, arranging and packing "saman." This account has omitted details about this laborious occupation (at which I fear I did less than my share) but done it has to be. We also paid off our excellent and cheery porters (23 of them--besides which we had also had 6 mules and 6 temporary men previously paid off and discharged).

And so into motor cars (what a joy to be carried again in even a ramshackle taxi instead of laborious though, may be, enjoyable trudging) and down to Siliguri where the bustle of a railway station was almost overpowering. We reached Siliguri at about 5-30 P.M. and immediately ordered a large meal and ate such quantities that the kidmatgars could not conceal their surprise. Fresh bread was truly a delight, comparable to the pleasure of eating real English

bread and butter again after 3 or 4 years in India. And then we separated, my cousin to join his work at Shillong and I to Calcutta on my way to Bihar and Orissa. So it was all over and glad though I was to be back, I shall never regret the trip and shall always look back on it as a most enjoyable experience and a fitting close to a long Home leave. And I recommend strongly that anyone who feels he would like a holiday of 3 to 4 weeks away from the world to travel into Sikkim. He need not go so far afield as we did. He can keep to bungalows and yet enjoy magnificent scenery, wild and grand, without hardship. On the other hand, he can go further, explore into snows and rocky mountains and experience the thrill of climbing passes and peaks whose very difficulties increase and magnify the grandeur of the views that somehow uplift one's thoughts, even though temporarily. All is so grand, pure and undefiled. But, as a warning, as nature becomes purer, grander, more austere and unforgiving, so does one's own enthusiasm, purpose and, with it all, good temper deteriorate. But it is an experience well worthy of cultivation.

And so I close this story and fulfil my obligations to the Editor of *The Indian Forester*. I apologise for the personal point of view expressed throughout. But it may interest some who like myself are no skilled or experienced mountaineers. I may have shown how an inexperienced man will enjoy mountains and something of what he may expect. Those who have climbed before will no doubt find all I have written tedious and matter-of-fact, and complain that I have over-emphasised difficulties. This no doubt I have done, but it was all new and strange, arduous and yet so fascinating that I should like to go again to discover whether the confidence I was undoubtedly gaining remains, and to enjoy again the grandeur, fascination and cruel beauty of the Himalayas.

A NOTE ON CRYPTOMERIA JAPONICA DON.

By C. K. Homfray, I.F.S.

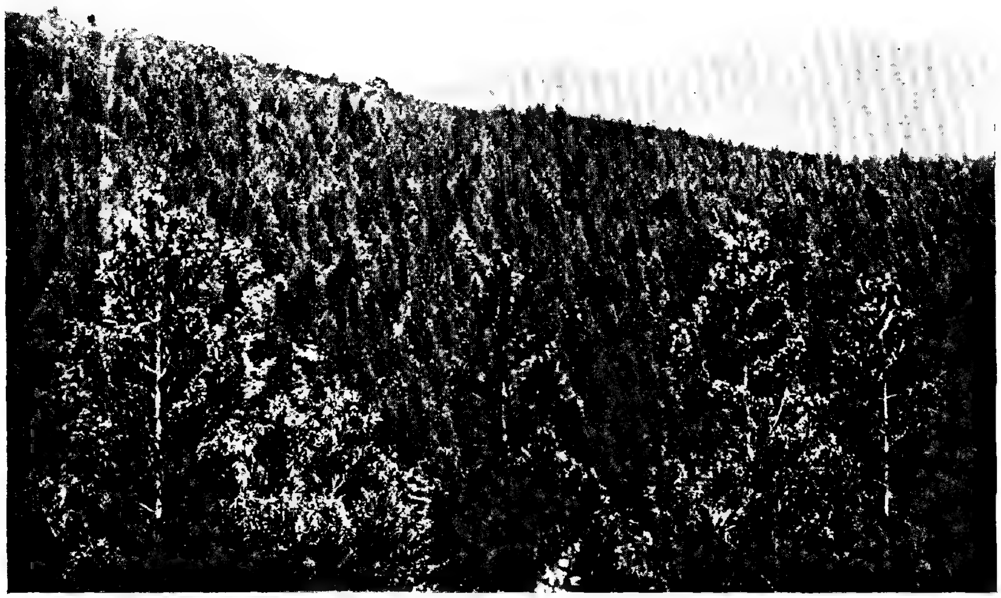
Cryptomeria japonica Don. (Taxodiaceae). Japanese cedar. Sugi (Japanese), Dhupi (Nepalese).

A large evergreen tree attaining in Japan a height of 150 ft. or more and a girth of 20 to 25 ft. Trunk with a broad base, tapering upwards. Bark reddish brown, peeling off in long strips. Needles awl-shaped, quadrangular, with decurrent bases, arranged spirally in five ranks. Flowers monœcious. Male flowers clustered at the end of the branchlets; female flowers at the end of the branchlets, globose, cone-like, covered with small awl-shaped leaves. Cones woody, globose, brown, 0·7 to 0·8 inch in diameter with scales bearing acuminate bracts partly adnate to them. The growth of the shoot is often continued through the cone. Seeds 0·15 to 0·25 inch long compressed, angular. Wood soft, fragrant, with a reddish brown heartwood.

The tree is indigenous to China, as far as is known only in the mountains of the Chekiang and Fokien provinces. In Japan natural stands are distributed over the hills along the coast where the climate is damp with an abundant rainfall and on a well drained rich soil. It occurs generally sporadically in mixture with other conifers and broad-leafed trees. In the North-East it is found mixed with *Thujopsis* and *Thuja* and in the South-West with *Chamœcyparis, Abies firma* and *Tsuga*.

It is found on granite, sandstone, shale, clay-slates, tertiary and volcanic rocks, on sandy and clayey soils at altitudes varying from 100 to 1,000 meters.

In Japan it is the most widely cultivated of all trees for afforestation purposes, and thrives well in a damp cool climate with a fairly heavy rainfall, ranging between 60 ins. to 96 ins. per annum and a mean monthly maximum temperature of 80° Fahr. and a mean minimum of 37° Fahr., but in the mountains where it is wild the climate is probably cooler and the rainfall heavier. The rainfall is well distributed, but heaviest between March and October.



Artificial plantation of *sugi* (*Cryptomeria japonica*) in Akita Prefecture (Japan), age 23.

Natural forest of *sugi* (*Cryptomeria japonica*), Akita Prefecture, Japan.

Cryptomeria has been introduced with success into many parts of the world and appears to stand a wide range of climatic conditions, although it thrives best in somewhat moist situations and on a rich soil. The following notes may be of interest showing under what different conditions it has been put out in different parts of the world :--

Australia.—In Queensland it has been introduced recently, but has not been thoroughly tried. It will not stand severe drought.

British Isles.—Grows fairly well in all but the coldest parts provided the soil is moist and fertile. Does not thrive on dry soils or exposed situations.

Kenya.—It is growing slowly at high elevations but has failed in Nairobi.

Mauritius.—It was introduced in 1884. There are plantations dating from 1908. Thrives best at 1,400 ft. to 1,850 ft. elevation with a rainfall of about 100 ins. Is invaluable as a shade-bearer for restocking blanks in the indigenous forest. Will not stand drought. Stands wind when established but needs protection in youth. Tall trees resist cyclones. Was formerly cultivated from seed, but has more recently been grown from rooted cuttings.

Nyasaland.—Shows promise at elevations over 4,000 ft. but unsatisfactory at lower elevations.

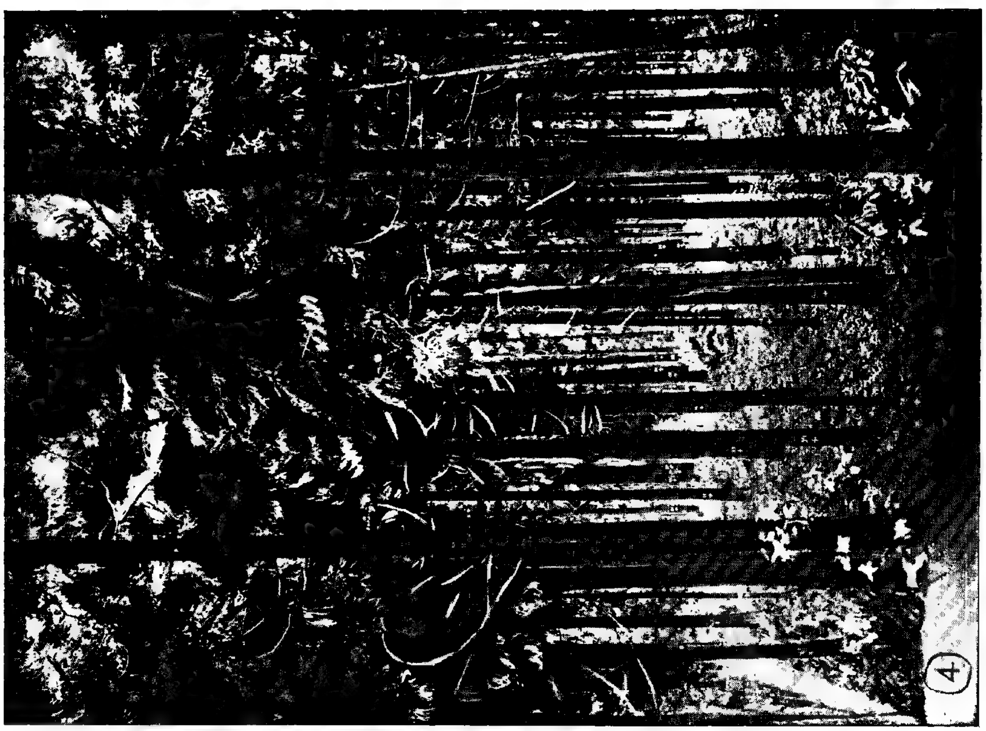
Union of South Africa.—Was first introduced in 1878 and the oldest plantations date from 1903. It is chiefly grown on deep loamy soils derived from dolerite, sandstones, and shales, on mountain slopes and foot-hills where the original vegetation consisted of grasses with bracken. It thrives in moist temperate mountainous localities and resists snow well. Rainfall 35 ins. to 75 ins. with maximum temperature of 72° Fahr. to 85° Fahr. and minimum 35° Fahr. to 53° Fahr. The mean annual height growth is 2 ft. to 3 ft. and the mean annual volume production per acre is 150 to 250 c.ft. Young trees are apt to be damaged by game and mice.

Ceylon.—It has been planted in the hill country round Nuwara Eliya at 5,000 ft. to 6,000 ft. and grows best on deep fertile forest

soil. Rainfall 75 ins. to 100 ins. well distributed but heaviest in May/June and October/December. The average annual height growth is about 1 ft.

India.—Seeds were first brought to India in 1844 by Mr. Fortune on his first visit to China for tea-seed. The seeds were given by Mr. Fortune to Dr. Falconer, Superintendent of the Botanical Gardens, Calcutta, for distribution in the hill stations. It has done quite well at Shillong between 4,000 ft. and 6,000 ft. on moist soils, growing more rapidly than the indigenous pine (*Pinus khasya*). It has also done quite well at Ootacamund. It has been planted to a certain extent in the western Himalayas in Simla and other hill stations but does not do so well as it does further east in a moister climate. It has been tried in the Kangra Division, Punjab, during 1915-1917 with little success, and again in Jaunsar in the United Provinces it was only successful in sheltered valleys up to 4,000 ft.; these failures are undoubtedly due to insufficient rainfall and lack of humidity. It is now quite naturalised in the Darjeeling District of Bengal and has been planted at elevations from 3,000 ft. to 8,000 ft. but does best from 4,000 ft. to 7,000 ft. Below 4,000 ft. it does not look healthy and growth is very slow. Above 7,000 ft. is very slow growing and has a stunted appearance and tends to be conical with less height growth. It grows best on a good deep rich soil but also does better than most of the indigenous species on comparatively shallow soils on exposed spurs and ridges. The soil throughout the hills is an excellent forest soil and of remarkable depth. It is formed by the decomposition of gneiss rock and is admirably suited to the growth of forest trees. The rock is folded and fractured to such a degree that even when it is not much decomposed plants are able to introduce their roots into the numerous fissures and cracks. The geological formation is known as the Sikkim or Darjeeling gneiss and is of a fairly uniform character throughout, except in the north-western portion of the Ghoompahar Range where a quartzose rock is extensively found. It is much shattered and breaks up into angular fragments. The constituents of the gneiss occur in varying proportion and the soil varies in the same relation. That most commonly met with is

Felling of *sugi* (*Cryptomeria japonica*).



Sample Plot No. 24 of *Cryptomeria japonica*, aged 34 years, elevation 5,500'. Takdah, Darjeeling Division, Bengal.

rather stiff, generally reddish coloured loam, poor in lime. As a rule, there is greater depth of soil at southern and western aspects; the rock being, on the contrary, nearer the surface on the north and east slopes and in deep narrow valleys where the sun rarely penetrates. In such places there is generally more leaf mould, the surface soil is light and porous, and frequently covered with *begonias*, *ferns*, *cane*, *selaginella* or *moss*. The rainfall varies from about 100 ins. to 200 ins. with a mean minimum temperature of 31° and mean maximum of 68° Fahr. Humidity per cent. ranging from 68 in the spring to 94 in the rains.

The hills of Bengal therefore fulfil all the essential requirements of *Cryptomeria*, a cool climate, with abundant rainfall, great humidity, and a good well drained deep fertile soil.

Cryptomeria was first put out in nurseries at Jalapahar by Dr. Anderson in 1864-65 from seeds obtained from trees in the station of Darjeeling which had been put out in 1844. It was first actually put out in the forest in mixture with other species at Rangbul between 1874-75 and was sown at stake 10 ft. by 5 ft.; again in 1888-1890 at Rangirum, where planting was done in horizontal lines under shelter of lofty trees left after improvement fellings.

Mr. Manson in his Working Plan for the Darjeeling Forests (1891—1906) stated that *Cryptomeria* is very quick growing; succeeds well in the open or with a very light shade and will be useful for restocking blanks or poorly stocked areas at the lower edges of the forest, as cattle will not eat it. In such situations it should be planted closely say 5 ft. by 5 ft. Although he advocated growing it pure and close it was mostly put out as single trees mixed with other species 20 ft. by 6 ft., or for the purpose of demarcating roads, blocks and coupe lines, and except for a small area at Rangirum (S. P. No. 6 raised in 1896) and a few areas round Takdah which are represented by S. P. No. 24 raised in 1898, there are no pure areas older than 1918. *Cryptomeria* when grown mixed with other species grows far too fast and produces large quantities of soft wood useless for any purpose and the poor quality of timber produced under this

system has caused the wood to be looked on with disfavour around Darjeeling.

Cryptomeria must be grown pure and kept dense if good wood is to be produced, it is reported that wood exported from Japan has from 10 to 12 rings to the inch. As an example of how quickly *Cryptomeria* will grow in the open, a road-side tree felled at Rangirum at an elevation of 6,300 ft. gave the following measurements :—

Age.	B.H.D. (U. B.)	Height.	Volume in c.ft.	MEASUREMENT OF RINGS AT 4'—6" (DIAMETER).					
				10 Rings.	20 Rings.	30 Rings.	40 Rings.	50 Rings.	60 Rings.
				Average in diameter at 4'—6".					
60	36"	106	272	4·8"	15·7"	22·3"	27·2"	31·6"	35·4"

Cryptomeria has only really been put out pure to any extent from 1918 onwards and the following is now the routine method of artificial regeneration :—

The seed ripens end of October, November and December. 13 lbs. of cones give 1 lb. of cleaned seed. There are 750 cones to the lb.; 9,200 seeds to the ounce. Cones are collected from the trees by lopping the branches and are then put out in the sun to dry and seeds are extracted by gentle thrashing, they are then stored in a dry ventilated shed until February when seeds are sown broadcast mixed with ash, fine earth or leaf mould in shaded nursery beds. One pound of seed will suffice to sow up a bed 6 ft. by 12 ft. known as a *kamra*. The seed beds are often covered with brushwood to hasten germination. It is a good germinator and gives up to 80 per cent. within 3 to 4 weeks. Watering is done daily in the nursery beds but less frequently in the pricking out beds. Pricking out is done 3 ins. by 3 ins. or 4 ins. by 4 ins. into shaded beds in June of the first year and shades are removed after about 3 months. It is a slow grower in the nursery and seedlings are usually kept there for two years, but recently it has been the practice to keep plants in the nursery for 3 years and put out when 3 ft. to 4 ft. high, this method has been extremely successful and has given a less number of casualties than with smaller plants, and in addition there is a great saving in clean-

ing and weeding as the plants are above weed growth when put out. In Japan three-year old plants are also used but young plants are pricked out twice and shades are kept on for a full year. When plants are kept so long in the nursery it is advisable to put up a temporary nursery at least two years ahead of the actual clear-felling in that area, this will save the cost of carrying such large plants over long distances. The felling of the coupes is completed by January, burning is done in February/March. Field crops consist mainly of Indian corn, potatoes, millet, the first crop put out is usually Indian corn which goes out in May. Potatoes are the chief crop in the 2nd year together with indigenous vegetables. Transplanting of *Cryptomeria* is done 6 ft. by 6 ft. entire with or without balls of earth in June. Cold weather planting in December and January is also successful. Planting of cuttings taken from branches of varying sizes from 9 ins. to 2 ft. 6 ins. in length have been tried experimentally but with no real success. A small experiment with cuttings taken just below a fork and put out in a damp and shaded area gave about 50 per cent. survivals but all experiments tried in open plantations completely failed. In southern Japan and Mauritius plants are raised more cheaply and quickly from cuttings taken from terminal parts of the side branches and attended to for 9 or 10 months in the nursery in order to form a good root system, but this method has not been tried in Bengal. It is not advisable to do too much cleaning of the undergrowth in exposed positions. Though mostly put out pure experiments have been made in mixing with other species, alternate lines of *Cryptomeria* and *champ* (*Michelia excelsa*) so far appear to be doing well ; also has been put out in alternate lines with *utis* (*Alnus nepalensis*) and makes an excellent second storey to the fast growing *utis*. The rate of growth in plantation is slow until the third year. The average rate of growth at an elevation of 6,300 ft. was found to be 1st year—1 ft. 3 ins., 2nd year—2 ft. 5 ins., 3rd year—3 ft. 11 ins., 4th year—6 ft. 10 ins., 5th year—10 ft. 1 in.

In Japan the method of raising *Cryptomeria* is also by clear-felling and planting but about 4,000 plants are put out per acre

(say about 3 ft. by 4 ft.). Pruning is done from the 8th to 20th year and the first thinning is done at the earliest at 12 years, but here the first thinning produces a profitable source of revenue, whereas in Bengal it does not.

Consequently at the suggestion of Mr. Trevor, Inspector-General of Forests, plots have been laid out to study the effects of different spacing, *i.e.*, 6 by 6, 7 by 7, 8 by 8, to see if by wider spacing unremunerative thinning can be deferred; in addition plots 4 ft. by 4 ft. and 5 ft. by 5 ft. have been laid out for comparison with the spacing in vogue in Japan. The question of spacing and thinning is intimately connected with the quality of the timber; past experience has shown that fast grown trees produce a large proportion of very soft sapwood. There appears to be a great difference in the constituency of the sapwood and the heartwood and the former is of little value. Much of the timber sold in the past has been from fast growing isolated trees with only 2 rings or less to the inch and this has made the wood unpopular in the district. Even in our pure plantations the rate of growth appears to be about 3 to 4 rings to the inch. Little thinning has been carried out in the past and plantations growing in their most optimum locality were not considered ready for thinning before the 15th year. The following plots were laid out in 1932 at Lopchu at an elevation of 5,900 ft. to study the effects of different grades of thinning :—

Age.	Grade of thinning.	Number of plants per acre after thinning.	Average crop height.	Average crop diameter in inches.	REMARKS.
12	Unthinned ..	988	36	5·4	
12	Ordinary heavy thinning "C" grade	726	34	4·9	
12	Ordinary heavy thinning "D" grade	500	36	5·4	

It is now suggested that a tree should be grown to produce sufficient heartwood and at a rate of 5 to 6 rings to the inch. This will require research into our planting and thinning technique and

our rotation will have to be adjusted accordingly. The rotation adopted in Bengal is 60 years except at Lopchu where it is 40 years. This in view of delayed thinnings will be too low and it will have to be raised to about 90 years or more. It is also to be decided whether it would be advisable to grow *Cryptomeria* at higher elevations on poorer soils with wider spacing and so get slower growth and save unprofitable thinnings, or to grow it at lower elevations and keep it dense for many years with the possibility of a larger outturn per acre.

In Japan the final felling takes place at about 120 years when as many as 180 trees containing 15,000 c.ft. may be found per acre. The previous thinnings are estimated at 16,000 c.ft., making the total product per acre at 120 years over 31,000 c.ft. This seems astonishing but S. P. No. 8 of Rangirum compares very favourably with this and at the age of 37 years there are 156 trees to the acre containing 10,290 c.ft. with a volume of 12,554 c.ft. from previous thinnings. *Cryptomeria* has a narrow crown and there is no doubt that plantations of this species have a higher increment per acre than those of any other species at elevations at which it grows. The attached table, an extract from sample plots, gives some idea as to the rate of growth in Bengal.

As regards diseases and pests they so far have been few and not really serious. Seedlings are sometimes destroyed by insects in the nursery which eat them off at ground level. Rats often kill young plants from 4 to 8 years by girdling same at ground level, this damage has been especially severe in some areas, and in this connection it is interesting to note the remarkable power of resistance the tree has, putting down aerial adventitious roots from above the affected part and often recuperating by this method. Young plants are sometimes damaged by a species of *Cossidae*, the larvae of which bores a gallery through or round the stem thus weakening it, and it is then broken off by wind. At higher elevations wind seem to retard growth more than any other factor. Is seldom damaged by frost, but in winter the foliage of young plants turns brown owing to the cold, but becomes green again as soon as the spring starts.

In South Africa, cracking of the stems occurred in some plantations a few years ago. It has not been possible to explain the cracking satisfactorily and replies received from authorities in Japan and elsewhere indicated that it is not known to occur in other countries. Further examination of the older trees at Benvie in Natal (over 30 years of age) showed that it certainly occurred in them many years ago. Fresh occurrences of it are being watched for with a view to connecting it with the conditions of weather, etc., probably causing it.

In its natural habitat *Cryptomeria* establishes itself naturally under pure or mixed stands of other conifers and broad leaved species. It comes up on soils with scattered plants of *Dicranum*, *Pognatum*, *Viola* or with scattered groups of *Eurya*, *Rhamnus*, etc. It is reported that a moist floor with a light ground cover of humus not more than 0·5 c.m. in depth and a canopy permitting of alternating condition of light and shade are ideal for its germination. If the overhead cover becomes too dark it gets very slender and bends but as soon as there is some opening in the canopy these plants shoot up healthy and vigorous. In Bengal little is known of the conditions suitable for its reproduction but from observations made up to date the conditions would appear to be exactly those mentioned above. After seed time the floor of the forest around parent trees is covered with little seedlings about the cotyledon stage, but if the canopy is dense these all soon disappear. At Sureil at an elevation of 5,500 ft. natural regeneration is excellent. This area belongs to the Cinchona Department and trees were removed to make boxes during the war, and in order to cope with their requirements very heavy thinnings were made. With the drastic opening up of the canopy hill fodder grasses, ferns, also scattered seedlings and advance growth of *Maesa*, *Eurya*, *Schima*, *Symplocos*, *Quercus*, etc., grew up, and amongst this the young *Cryptomeria* came up.

The plantation is now 55 to 60 years old with 116 trees to the acre and young regeneration was first noticed about 15 to 20 years ago and came up very thickly. A large majority of them were collected for planting up other sites. An enumeration of seedlings this year over 1 acre plots gave 203 seedlings per acre ranging from 6 ins. to 24 ft. in height and 2 ins. to 2 ft. 6 ins. in girth.

In view of this excellent result Sample Plot No. 6 at Rangirum aged 37 years was very heavily thinned in 1932 down to 156 trees per acre and permanent gaps were formed in the canopy. Before this young regeneration appeared annually but the canopy was dense with no undergrowth and so it disappeared each year. Immediately on opening up the canopy a light ground cover of fodder grass came in all over the area and small clumps of advance growth of *Eurya*, and *Symplocos* sprang up. The plot was inspected in September 1934 and a large number of two-year old seedlings were found and these appeared healthy and established. Results at Sureil and Rangirum confirm that the condition for successful regeneration are exactly those occurring in its natural habitat. That is, a light ground cover is essential, humus should not be too deep, and the canopy opened so as to permit of alternate light and shade.

As regards established regeneration observations in Bengal show that *Cryptomeria* will remain in a suppressed condition for many years, and 17-year old saplings 20 ft. high and 3 ins. diameter have been found under a comparatively dense shade of oaks and other miscellaneous species. The plants looked extremely healthy, and as soon as the cover was removed and light let in, they immediately responded.

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Homfray .. .. Nursery and Plantation Notes for Bengal 1933.

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CRYPTOMERIA JAPONICA.

Age of crop.	Main Crop. Number of trees per acre after thinning.	Main Crop. Average height of the crop.	Main Crop. Average diameter.	Main Crop. Volume per acre. Stem timber.	Main Crop. Volume per acre. Small-wood. Stem.	Main Crop. Volume per acre. Small-wood. Total.	Main Crop. TOTAL.	Intermediate Yield from Thinning. Number of trees.	Intermediate Yield from Thinning. Average height.	Intermediate Yield from Thinning. Average diameter.	Intermediate Yield from Thinning. Volume per acre. Stem timber	Intermediate Yield from Thinning. Volume per acre. Small-wood. Stem.	Intermediate Yield from Thinning. Volume per acre. Small-wood. Total.	Intermediate Yield from Thinning. TOTAL.	Total Crop. Timber.	Increment of Final Crop. Periodic. Stem timber	Increment of Final Crop. Periodic mean. Stem timber.	REMARKS.
Years.		Feet.	Inches	Solid c. ft.					Feet.	Inches	Solid c. ft.					Solid c. ft.		
Sample Plot No. 6 of Darjeeling Division at Rangirum. Elev. 6,300 ft.																		
22	296	65	11·5	4,146	2,092	2,092	6,238	408	48	7·2	1,182	1,517	1,517	2,699	5,328	..	..	
27	272	75	13·7	7,377	1,272	1,272	8,649	24	69	11·4	358	169	527	527	7,735	3,589	718	
32	240	85	15·9	10,236	945	945	11,181	32	78	12·1	608	217	217	825	10,844	3,467	693	
37	156	91	18·4	9,759	531	..	10,290	84	81	14·4	2,795	406	..	3,201	12,554	2,318	464	
Sample Plot No. 32, Darjeeling Division at Senchal. Elev. 8,000 ft.																		
32	553	43	9·2	2,714	1,883	1,883	4,597	28	38	6·4	6	98	98	104	2,720	..	..	High level Cryptomeria
Sample Plot No. 24, Darjeeling Division at Takdah. Elev. 5,500 ft.																		
31	302	72	10·4	3,913	1,860	1,882	5,795	112	57	6·3	169	538	538	707	4,082	..	..	
Sample Plot No. 26, Darjeeling Division at Takdah. Elev. 6,300 ft.																		
12	1040	28	4·5	..	1,502	1,502	1,502	43	18	1·8	..	3	3	3	..	..	..	
15	893	34	5·8	209	2,726	..	2,935	146	30	4·1	..	210	210	209	209	209	70	
Sample Plot No. 33, Darjeeling Division at Debrepani, Elev. 6,260 ft.																		
10	974	28	4·3	..	1,277	1,277	1,277	..	..	..	..	..	..	..	..	..	..	
Sample Plot No. 27, Darjeeling Division at Lepchajagat. Elev. 6,225 ft.																		
8	804	23	3·9	..	685	685	685	..	..	..	..	..	..	..	..	..	..	

NOTE BY THE FOREST ECONOMIST ON 3 LOGS OF CRYPTOMERIA JAPONICA RECEIVED FROM BENGAL ON 27TH SEPTEMBER, 1934.

The three logs of *Cryptomeria japonica* were sent for test to compare the wood with that grown in Japan, and to see if there was any difference between so-called "slow grown" Bengal trees and the ordinary fast grown trees from about 6,000 ft. elevation. The logs sent were as follows :—

No. 1 from a tree grown in the open at about 6,000 ft. (optimum).

No. 2 from a tree close grown at 6,000 ft.

No. 3 from a tree close grown at 8,000 ft. (upper limit).

Detailed reports by the Wood Technology, Timber Testing, Wood Preservation and Wood Working Sections may be summarised briefly as follows :—

(1) Bengal *Cryptomeria japonica* from all sources is too fast grown to yield really good wood. The rate of growth is about 3 rings to the inch as compared with the Japanese wood at 16 rings to the inch.

(2) There is no difference between the wood from open grown and close grown trees, nor does elevation appear to affect the rate of growth to any measurable degree.

(3) That this species can be treated with preservatives and absorbs preservative well if a high pressure is used.

(4) That this fast grown Bengal wood is no good for peeling or plywood work.

(5) That it is easy to saw and plane, and can be turned sufficiently well for cheap toys, etc. It is not however a really good turnery wood.

(6) That it takes nails well, and is considered suitable for light cheap packing cases, treated ceiling boards, linings, partitions, shingles (if wide headed nails are used), and for insulation work and cheap toys.

POSSIBILITIES FROM IRRIGATION OF DRY TYPE HILL FORESTS.

BY W. D. M. WARREN, I. F. S.

One is accustomed to think of irrigation in connection with Agriculture, the Punjab and Sind in India, the Nile in Egypt and the river Murray in Australia being examples of where irrigation is being practised successfully, on a large scale, but I only know of one example. namely, the Changa Manga plantation in the Punjab where irrigation has been applied to Forestry, and in that case the irrigation scheme was primarily intended for Agriculture. One can be excused therefore for being surprised upon returning from leave fifteen months ago, to find that an experiment had been started in Kolhan Division to irrigate sal areas.

2. The scheme is designed to prevent the rapid run-off of water from steep hills by damming up-streams and their tributaries and diverting the water along contour channels, having a slight fall of 1 in 8,000 ft., *i.e.*, practically level. Not only does this prevent the stream water from running to waste, but all water trickling down the hillside is arrested at the contour channels, from where it can only reach the main stream by percolating through the soil in contact with the roots of trees, which are thereby enabled to obtain the water they require for a longer period than under normal conditions. The extra amount of water the trees thus obtain is much more than one would imagine. After one inch of rain had fallen in the first heavy shower of the last monsoon tests showed that the water had only penetrated two inches into the soil on a 30° slope.

3. An area was chosen in Santara 9 in the upper reaches of the Pagamara gara near Bamiaburu. The lower reaches of this stream before it joins the Sangajata nala run through quality I sal areas of Santara 9 and Santara 23 and here the stream is perennial. But in the upper reaches the stream dries up in December each year. The sal crop consists of quality IV trees 3 ft. to 5 ft. in girth, trees, which from their heights of 80 ft., one would normally expect to keep sound,

Fig. 1—*Main Dam* in course of construction. Note the contour channel on the left. Such a big Dam is not really necessary.

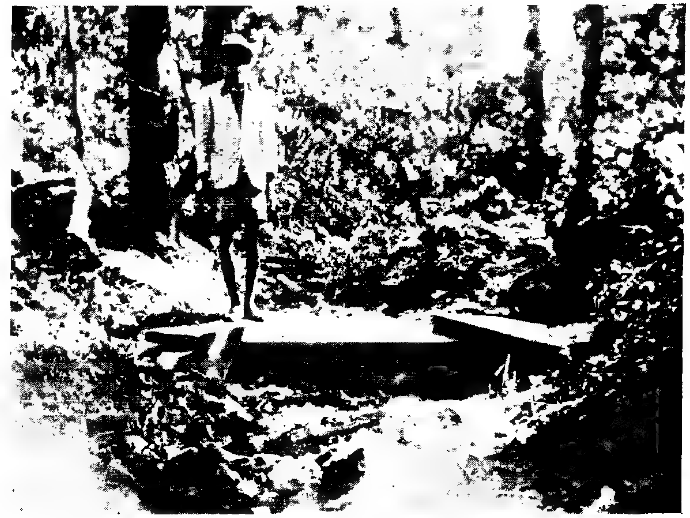

Fig. 2—Side Dam. The exit is lower than the entrance in order to ensure that the water flows only the one way and is not banked up by the stream.

Fig. 3—Photo taken in December 1934 after one year's irrigation.

Fig. 4—Photo taken in December 1934 after one year's irrigation. Note the luxuriance of the *sabai* and thatch grasses.

but which were showing decided signs of stag-headedness and unsoundness. Some were already top dry, a condition often due to insufficiency of water. The undergrowth consisted of scattered sal regeneration, *Diospyros melanoxylon*, *Gardenia gummifera*, *sabai* and other grasses, typical hill type sal ecology. The underlying rock is shale, the soil, a greyish clay loam. A better area for the experiment could scarcely have been chosen.

4. A concrete bandh 25 ft. long and 6 ft. high (See Fig. 1) was constructed in June 1933 at a point in this stream just below where it bifurcates. A contour channel 550 ft. long and large enough in cross section to take one foot of water was constructed on the right hand slope above the stream. This year the channel was lengthened to 1,528 ft. Another channel 1,080 ft. long has now been constructed leading along the left hand slope. At first the water of the contour channel where it met other streams was carried over by wooden flumes, hollowed out tree trunks, but later it was realized that the water should be led into and out of every stream, this being achieved by constructing a small masonry bandh across the stream to force the water from the contour channel. The channel therefore collects more water in every stream it meets. A protective bridge of masonry is constructed across the entrance to the contour channel in order to prevent excess water from running down the channel, the excess being made to pass over the bandh. The bandhs of the tributary channels are very small (Fig. 2), usually 4 ft. to 5 ft. across and 1 ft. to 2 ft. high, as the channel is continued on along the hill towards the stream until nearly stream bed level, before crossing.

5. In order to measure accurately the effects of irrigation, experimental and control plots were laid out, and the position and heights of all trees, shrubs and regeneration were shown on graph paper. The diameter of 52 sal trees in the neighbourhood were also taken at breast height. Remeasurements will be made in five years when some interesting results should be obtained. Photographs (Figs. 3 and 4) have also been taken at selected points and will be retaken once the change is sufficiently striking for the camera to record. Investigations are also being carried out to find the length

of time the water remains available in the streams below the treated area. The comparative degree of humidity in the drainage area after treatment, and its possible effects on climate will be studied. It is also possible that the vegetation produced will be sufficiently moist to offer serious resistance to fire and so help solve our fire protection problems.

6. Changes are to be observed even now upon the area. The undergrowth is undergoing a transformation, particularly where irrigation has been going on for two seasons. Fresh sal seedlings are appearing everywhere and show no signs of dying back, while regeneration formerly unnoticed in the long grass, is now 2 ft. to 3 ft. high. Moribund regenerations 3 ft. to 4 ft. high which formerly grew at the rate of only a few inches yearly is now sending out shoots 1 ft. to 2 ft. long. In an area below the new channel constructed before the rains, sal then 6 ft. to 7 ft. high is now 8 ft. to 9 ft. One marking nut tree *Semecarpus anacardium* then 12 ft. is now 15 ft. These growths may not be records for the species but they certainly are for the area. In short the regeneration looks vigorous and healthy and is fast taking on a valley type appearance. Even tall trees have lost their stag-headedness under the influence of a fresh flush of leaves and shoots. It scarcely seems premature therefore to predict that the new crop will be of at least quality II sal.

7. However encouraging the first results of the experiment may be, before it can be adopted on an extensive scale, it must satisfy one of two conditions :—

(*i*) Either the anticipated enhanced value of the forest crop is sufficient to earn a reasonable rate of interest on the money expended, or

(*ii*) The benefit to the community will be so great that the economic aspect need not be considered.

The scheme is fortunate in being able to satisfy both of these conditions.

8. *The economic aspect of the scheme.*— It is generally accepted that in view of the safety of the capital invested, the convenience of

the steady income it yields, and the fact that prices of forest produce fluctuate less than the value of money, the investor should be content with $2\frac{1}{2}$ to 3 per cent. compound interest on money invested in forestry.

So far Rs. 540 has been spent, Rs. 208 on the main Dam, Rs. 180 on the five side ones, and Rs. 152 on 2,608 feet of contour channels. The area influenced to date is approximately 13 acres,* $9\frac{1}{2}$ acres below the contour channels, $2\frac{1}{2}$ acres above, and one acre above the main bandh so that the cost per acre is Rs. 41-8. (*This will probably increase considerably in time as the effects above and below the channel are progressive and accumulative.)

9. In calculating the anticipated yield per acre of the new irrigated crop, I am assuming from its appearance that it will keep sound to 24 ins. diameter and that it will reach that diameter in 120 years. Our best sal areas can produce that girth in 90 to 100 years while Howard's quality I sal yield tables interpolated show an average diameter of 24 ins. in 106 years. On the other hand, quality II yield tables show an interpolated diameter of 20·8 ins. in 120 years. The assumed quality of the new crop is therefore intermediate to these qualities. From the yield tables intermediate quality figures for average diameter of trees and numbers per acre at different ages have been worked out for comparison with figures for quality III sal, the assumed quality of the crop before irrigation. (The quality is actually quality IV but there are no yield tables for this quality.) The figures are given below.

INTERMEDIATE QUALITY.			QUALITY III.			REMARKS.
Age.	Average diameter of trees in inches.	Stems per acre.	Age.	Average diameter of trees in inches.	Stems per acre.	
1	2	3	4	5	6	7
50	12·0	160	50	..	..	
60	13·9	126	60	..	..	
70	15·4	103	70	..	..	
80	16·9	86	80	12·8	128	
90	18·4	73	90	14·0	107	
100	20·4	63	100	15·2	90	
110	22·4	53	110	16·4	80	
120	24·4	43	120	17·5	70	

It should be noted that for the intermediate quality (I and II), not only are the average tree diameters greater at a given age but that this yield carries an enhanced price.

10. For the sake of simplicity, trees are sold in diameter classes, each diameter class receiving a different unit value based upon the yield and market value of an average tree of that class. Thus 12 ins. to 16 ins., 16 ins. to 20 ins., 20 ins. to 24 ins. and 24 ins. to 28 ins. diameter classses have unit values of ½, 1, 2 and 3.

The unit value in quality I and quality II areas is now Rs. 7. Unsoundness is negligible. For quality IV area, however, the unit value is Rs. 4 per sound tree unit, but 33⅓rd per cent. unsoundness reduces this value to roughly Rs. 2-8-0 per unit. In both cases trees of the 12 ins. to 16 ins. diameter have been given lower unit money values to conform with market prices. To effect a comparison between the money yield of the two qualities, it is necessary not only to take note of the final yield, but also the intermediate yields at 10 yearly intervals multiplied up to the end of the rotation by the appropriate interest per cent. The yields are given below.

Yield from Intermediate I—II Quality for one acre.

Age at which yield taken.	No. of trees.	No. of units per tree.	Total No. of units.	Value per unit.	Total value of yield in rupees.	No. of years to end of rotation.	Amount to which Re. 1 accumulates in that period (Col. 7) at 3·5 percent. compound interest.	Total brought up to end of rotation. Col. 6 by 8.	
1	2	3	4	5	6	7	8	9	
				Rs.	Rs.			Rs.	a.
120 yrs.	43	3	126	7	882	Nil	..	882	0
110 ,,	10	2	20	7	140	10	1·4106	197	8
100 ,,	10	2	20	7	140	20	1·9898	287	9
90 ,,	10	1	10	7	70	30	2·8068	196	8
80 ,,	13	1	13	7	91	40	3·9593	360	4
70 ,,	17	½	8½	5	42·5	50	5·584	247	4
60 ,,	13	½	6½	5	32·5	60	7·878	256	0
50 ,,	34	½	17	5	85	70	11·1128	944	9
							Total	3,371	10

Yield from Quality III Sal for one acre.

Age at which yield taken.	No. of trees felled.	No. of units per tree.	Total No. of units.	Value per unit.	Total value of yield in rupees.	No. of years to end of rotation.	Amount to which Re. 1 accumulates in that period Col. 7 at 3·5 percent. compound interest.	Total brought up to end of rotation. Col. 6 by Col. 9.
1	2	3	4	5	6	7	8	9
				Rs. a.	Rs.			Rs. a.
120 yrs.	70	1	70	2 8	175	Nil	..	175 0
110 ,,	10	1	10	2 8	25	10	1·4106	35 4
100 ,,	10	½	5	2 0	10	20	1·9898	20 0
90 ,,	17	½	8½	2 0	17	30	2·8068	47 12
80 ,,	21	½	10½	2 0	21	40	3·9593	83 2
							Total ..	361 2

The enhanced yield to be expected from the irrigated sal is, therefore, Rs. 3,171-8-0 – Rs. 361-2-0=Rs. 2,810 approximately. This is $\frac{2810}{41\cdot5}$=nearly 68 times the cost of irrigating the area. As one rupee accumulates to Rs. 60 in 120 years at 3½ per cent. compound interest the return is seen to be slightly better than 3½ per cent. A return of 4 per cent. compound interest can be expected if the main dam is taken higher up the stream than was done in this case, it being unnecessary to construct a bandh of 25 ft. Rs. 170 out of Rs. 540 spent could have been saved if the cost of this bandh had been no more than the average cost of the other five side ones.

11. *The benefit to the Community.*—So far only the strictly financial side of the scheme has been examined. But of even greater importance are the intrinsic benefits which would accrue to the community at large by the improvement of rainfall, and the lessening of flood damage, and the possibility of utilising the delayed run-off in these higher areas in irrigation schemes for the benefit of the agricultural community. In this connection I cannot do better than refer to passages from the report of Mr. J. A. Hubback, I.C.S., on the

Orissa flood problems. In para. 44 he dismisses as financially impracticable all schemes for controlling the discharge passing through the head of delta by large reservoirs constructed in the upper valleys of the Mahanadi, the Brahmani, the Baitarani and their tributaries and suggests that a number of small works might affect the discharge.

In para. 45 he describes experiments which have been conducted at Kanke for securing sufficient water for the rice crop by leading the water along contour channels as in this experiment, and states that all who have observed that experiment agree that the run-off is spread over a large number of days and its violence greatly diminished. He wishes to extend this principle to the cultivated lands of the catchment area of the Mahanadi and other big rivers.

In para. 46 Mr. Hubback examines the data available of two recorded floods of the Mahanadi and then considers what would be the effect supposing that " by a large number of small works on the Kanke lines we could ensure that one per cent. of the run-off of the Mahanadi catchment area was retarded one day, 1 per cent. by two days, 1 per cent. by three days, 1 per cent. by four days and 1 per cent. by five days."

In para. 47 he shows that if the maximum discharge of the 1911 flood had been reduced by 6 per cent. for each of five days and the 1920 flood by 4 per cent., these floods would probably not have occurred.

12. *Para. 48 of Mr. Hubback's report.*—" I am inclined to think that the retardation would in practice be spread over a much longer period than five days, and this would, for the same catchment area controlled, enhance reduction of the maximum discharge. Whether it would be feasible to control in the manner I have indicated a sufficient catchment area to secure a really material decrease in maximum discharge I cannot say. But seeing that the plan of control is one which has already been proved to benefit cultivation at an expense which is amply repaid in few years, and not one involving immense capital outlay and recurring charges which give no other return than their primary object, it seems a proposal worth closer examination. If the coastal districts of Orissa can be relieved even to a

moderate extent, by a plan which will bring prosperity to the cultivators of Angul, Sambalpur and the Feudatory States, the sooner that plan is put into execution the better."

13. One other possible benefit should be mentioned. If irrigation schemes could be adopted on sufficiently wide scale, would not the higher average annual low water level and the more controlled flood level combined with the reduced silting effect of the latter, tend to reduce all bar formations at the mouths of rivers and to open them up to better navigation for longer periods? Is not this also worthy of further examination by experts? Is Cuttack as a port of Orissa always to remain an unrealized dream?

14. This article began with a description of an irrigation experiment in dry sal areas. We have seen that it links up with a much bigger scheme for bringing prosperity to the toiling masses of India. I wish now to emphasise the part that we, Foresters of British India and the Native States, can play in this great work. The upper catchment areas of all the great rivers of India lie in hilly forest areas, largely under our control. We are perhaps better organised than any other department to undertake the work. Let us then not be dismayed by the magnitude of the task which lies before us, but rather let us remember that we get our reward momentarily for anything that we do; and the pleasure, which would be ours, at seeing poor decrepit forest transformed into something worth looking at, is an even better reward.

MAIYANG (DIPTEROCARPUS SP.) IMPORTED FROM SIAM.

Certain railways in India have used this timber in their carriage and wagon shops and found it very suitable for the purposes required. There has been, however, considerable uncertainty as to exactly what species of *Dipterocarpus* this timber was. It was previously thought that it was identical with Burmese *eng* (*D. tuberculatus*) but apparently this is not so. The following note by the Forest Botanist of the Forest Research Institute should go a long way to decide this question.

"Craib in Florae Siamensis Enumeratio (1931), pp. 133-139, gives 15 species of *Dipterocarpus* as occurring in Siam. Of these two species, *i.e.*, *incanus* and *skinneri* have already been reduced and two species, *schmidtii* and *oblongifolius* are apparently very uncommon.

The remaining eleven species resolve themselves into two types, the Dry Dipterocarps and Evergreen Dipterocarps.

The Dry Dipterocarps are *D. tuberculatus*, *obtusifolius* and *inbricatus*. The Siamese names of these trees are generally ***Pluang*** or ***Kuang*** or ***Kieng***, comparable somewhat with the ***In*** or ***Eng*** of Burma. It is unlikely that ***Maiyang*** would be a name given to any of these.

The Evergreen Dipterocarps comprise the following eight species:—*alatus*, *angustialatus*, *D. pilosus* Roxb., *costatus*, *duperreanus*, *grandiflorus*, *hasseltii*, *kerrii* and *turbinatus*.

Of these the commonest species are *alatus* and *turbinatus* to which names ***Yang*** are given both by Craib in the work cited above, and by Ryan and Kerr in their note on the Dipterocarpaceæ of Northern Siam. ***Maiyang*** as supplied to the railways would most likely be one of these two, but which one I cannot say."

Moreover, a comparative anatomical study of ***maiyang*** and ***gurjan*** or ***kanyin*** in the Wood Technology Section of the Forest Research Institute did not reveal any difference between them. It can, therefore, be said that if the wood-using industries in India use ***gurjan*** or ***kanyin***, instead of ***maiyang*** they will be getting the same timber and probably there will be no cause for complaints.

NAINI TAL FOREST DIVISION.

BY J. R. SINGHA, D.F.O., NAINI TAL.

1. *Situation.*—But for a small area towards north-east, which is in the Almora district, the whole division lies in the Naini Tal civil district and almost abuts its northern and eastern limits. The division mainly occupies the outer Himalayas and includes practically all the hill forests of the Naini Tal district which lie south of the Kosi river, east of the Ramnagar and north of the Haldwani forest divi-

sions and west of the watershed between the Ladhiya and Gaula rivers.

The headquarters of the division, Naini Tal, which is also the summer residence of the U. P. Government, and the Eastern Command, is situated roughly in the centre of the division and is about 13 miles by bridle path and 22 miles by motor road from Kathgodam. Bhowali with a most up-to-date and well-equipped sanatorium for tubercular patients, Bhim Tal with its fishing amenities, the Imperial Institute of Veterinary Research at Muktesar and the Provincial Bovine Lymph Depot at Patwadangar are also situated within the limits of the division.

2. *Extent and area.*—The division is about 42 miles long from north-west to south-east and 24 miles wide from north to south. Its total area is about 289 square miles, out of which only about 191 square miles constitute the old reserves and class II of new reserves. The rest is either class I of new reserves or the Panchayat forests, and the Forest Department has only a nominal control over these.

3. *Topography.*—The whole tract is mountainous with varying degrees of steepness and is cut up by many ridges and valleys. The elevation varies from 1,800 ft. at Kathgodam to 8,626 ft. at China peak. Certain places in the division afford a magnificent view of the snows and of the plains down below. The main drainage basins within the area are those of the Kosi, Gaula, Dabka and Nihal. The first main ridge of the Himalayas runs sinuously across the division from Mornaula in the east to Benaikdhura in the north-west. The presence of a number of small lakes is a noteworthy feature of the tract.

4. *Geology.*—The principal rocks found in the division are the Nahan sandstone over a narrow strip along the south, the Archean rocks consisting of gneiss, granite and mica schists towards the east and the north-east and the Purana rocks consisting of intrusive trap, slate, shale, quartzite and blue limestone elsewhere. The Nahan sandstone and the quartzitic formations bear some of the best *chir* forests of the division. The *chir* growing on the mica schist is, on the other hand, universally twisted and of very poor quality.

5. *Climate.*- The climate varies from temperate to subtropical in the lower valleys which become hot and oppressive in summer. Sharp frosts are common in winter and occur in valleys and depressions all over the division. During January and February there is snowfall above 5,000 ft., which, however, soon disappears except on the northern slopes of the higher ridges where it stays for several weeks. October, November and March are the most delightful months of the year as the weather is then very bracing and dry with clear skies. From April to the break of rains the weather is often stormy and thunderstorms with some hail may always be expected. The monsoon breaks about the middle of June and the precipitations are frequently very heavy. The average rainfall varies from 97 ins. at Naini Tal to 52 ins. at Muktesar.

6. *Water supply.*—Except in the Nahan sandstone, perennial springs are fairly common and all the main rivers have almost a permanent water supply. The water of a spring near Peora is said to promote digestion and possesses some medicinal properties.

7. *Roads and paths.*- Except the north-western portion, the division is well-equipped with bridle roads and foot paths. The motor road from Kathgodam to Naini Tal and to Almora also passes through the division.

8. *Flora.*—*Chir* (*Pinus longifolia*), *banj* (*Quercus incana*), *tilonj* (*Quercus dilatata*) and sal (*Shorea robusta*) are the common species of the division. The forests may conveniently be divided into the following main zones of vegetation :—

(*a*) ***The Oak Zone.***—It extends from the highest point in the division to 6,000 ft. on the northern aspects and to 6,500 ft. on the southern aspects. Towards its lower limit the oak follows the ravines down to about 3,000 ft. and leaves the spurs and ridges to *chir*. *Banj*, *tilonj* and *rianj* (*Quercus lanuginosa*) are the predominant species of this zone. *Kharsu* (*Quercus semicarpifolia*) and *phanyat* (*Quercus glauca*) occur gregariously over comparatively small areas only. *Rhododendron arboreum*, *Pieris ovalifolia*, *Euonymus tingens*, *Euonymus pendula*, *Myrica nagi*, and

Pyrus pashia are some of the commonest associates of oaks. Some silver fir and yew are also found mixed with *tilonj* on cool sheltered slopes over 7,000 ft. in the north-east of the division.

(*b*) *The Temperate or* Chir *Zone* from 3,500 ft. to 7,000 ft. on southern aspects and from 3,000 ft. to 6,500 ft. on northern aspects. The main species is *chir* associated with oaks, *Machilus* spp., *Alnus* spp., *Eurya acuminata*, *Myrsine semiserrata*, *Meliosma* spp., *jaman* (*Eugenia jambolana*) and *tun* (*Cedrela toona*) in hollows and nalas. Towards its lower limit the *chir* is often mixed with *genthi* (*Boehmeria rugulosa*) sal, *kachnar* (*Bauhinia variegata*), *aonla* (*Phyllanthus emblica*), *sandan* (*Ougeinia dalbergioides*) and other miscellaneous species. With fire protection the *chir* is extending into the *Sal-Kokat* zone lower down and oaks are encroaching upon *chir* higher up. The height varies from about 50-60 ft. in the poorest localities to 140 ft. in exceptional patches in the Gaula valley. The best growth is attained along nalas and on gneissose schists. The twisted trees are almost confined to a small area towards north east where the rocks are schistose or mica schists.

(*c*) The sal zone from 1,800 ft. to 4,000 ft. The chief species is sal associated with *asna* (*Terminalia tomentosa*), *sandan*, *genthi*, *kachnar pula* (*Kydia calycina*), *jaman*, *dhebri* (*Elæodendron glaucam*) and *rhoini* (*Mallotus philippinensis*). These forests are usually confined to the Nahan sandstone. A few patches of poor growth, however, follow the Purana rocks along the Gaula and Kosi valleys and their tributaries. The best growth is found in the vicinity of Ranibagh and Mangoli.

(*d*) *The Kokat Zone.*—It generally extends from 1,800 ft. to 5,000 ft. along the exposed slopes of the foothills and on very steep rocky or precipitous hot slopes with poor or no soil, *e.g.*, on trap rocks, on the very fractured shales

and slates (about Brewery) and on broken quartzite rocks. The vegetation in this zone is mainly composed of *asna*, *siris* (*Albizzia lebbek*), *bamboo*, *jaman*, *sandan*, *dhauldhak* (*Erythrina suberosa*), *jhingan* (*Lannea grandis*), *harr* (*Terminalia chebula*), *dhaman* (*Grewia elastica*). *tun*, *semal* (*Bombax malabaricum*), *kachnar*, *aonla* and *lassora* (*Cordia obliqua*).

In addition to the above some *kail* (*Pinus excelsa*) and deodar which have been artificially planted are also found in the vicinity of Kilbery and Benaik Forest Rest Houses.

9. *Objects and system of management.*—

(*a*) There is a great demand for fuel and charcoal at Naini Tal and other settlements within the division. The oak forests in the old reserves and in the new reserves within the economic radius of exploitation have all been set aside for this purpose. They are worked on a 10-year felling cycle under the Selection-cum-Improvement system with a fixed girth limit for exploitation. The yield has been fixed by area.

(*b*) The *chir* is in demand for resin and for timber required by right-holders, by residents of Naini Tal and other local hill stations and by the inhabitants of the plains specially in the Punjab. The demand of resin is met from *chir* areas situated within an economic radius of railhead, and the trees are worked under a continuous system of light tapping with a minimum girth limit of 3 ft. 6 ins. The *chir* areas situated in the basins of the Gaula and Kosi rivers with floating facilities and in the vicinity of Naini Tal and other local stations have been set aside to meet the timber requirements of the plains and of the local inhabitants other than the rightholders. They are worked under the Shelterwood system on a rotation of 120 years divided into four periods of 30 years each. The yield is fixed by volume and is based on enumerations in P. B. 1 down to 12 inches diameter class. The areas outside P. B. 1 are subjected to

improvement fellings and thinnings on a 10-year cycle.

The *chir* forests which cannot be commercially exploited at present for timber have been essentially earmarked to satisfy the demand of the right-holders. The fellings here are unregulated as regards yield but they are controlled by suitable silvicultural regulations.

(c) The sal and miscellaneous forest in the old reserves and the sal areas which are not too distant for exploitation are managed on a 10-year felling cycle under the Selection-cum-Improvement system. The yield is regulated by area with minimum exploitable diameter limits. These forests are intended to supplement the fuel and charcoal supply of Naini Tal, to meet the local demands for charcoal and firewood for lime burning and to satisfy the demand for sal and other hardwood timbers to a limited extent.

10. *Injuries.*—Fire is the greatest source of damage to *chir* forests and their successful management solely depends on effective fire protection. A lot of good work was ruined by the big fires of 1916, 1921 and 1931. The oak forests suffer appreciably from *Loranthus* attack and from lopping in the vicinity of habitations.

11. *Main Forest Products.*—The *chir* and sal timber and the oak fuel and charcoal mainly constitute the major forest produce extracted. The *chir* is mainly converted into B. G. sleepers, planks and boards whereas sal is converted into scantlings and ballies. As regards minor forest products resin, lime, road metal, building stone, torchwood, lichen and various medicinal herbs are exported in sufficient quantities.

The cooly carriage, floating in the basins of the Gaula and Kosi rivers, and carriage by lorry along the motor road are the chief means of transport of forest produce from the forest.

12. *Markets.*—Naini Tal, Kathgodam, Ramnagar, Bhowali, Bhim Tal, Jeolikote and Muktesar are the chief local markets for timber, fuel and charcoal. The only local market for resin is the distillery at Clutterbuckganj (Bareilly).

13. *The local population and their requirements.*—The rural population is mainly Hindu and their principal occupation is agriculture. The bulk of the population migrates to Bhaber for the winter. Their *bona fide* requirements for forest produce have amply been provided for in the way of rights and concessions. It may as well be noted here that the labour required for forest works is mainly imported.

14. *Shikar and fishing.*—The big game shooting is comparatively poor. The innumerable gun licences, the unrestricted shooting in the new reserves and the big incendiary fires in the past are mainly responsible for the scarcity of big game. Panther, Gural, Sambhur, Serow and Kakar are some of the chief animals found in the division. Tiger is also sometimes met with specially in the warmer localities adjoining the Ramnagar and Haldwani forest divisions. Pheasant and partridge shooting is, however, quite good in the autumn.

The Naini Tal lake and the lakes round about Bhim Tal provide good fishing in spring and summer. There are also some nice pools in the Gaula and Kosi rivers where fishing can be had.

TREATMENT OF TEAK SEED BEFORE SOWING IN TAUNGYAS.

BY R. W. V. PALMER, SILVICULTURIST, BURMA.

Methods of treating teak seed to secure early and even germination in *taungyas* have been studied for a long time in Burma. The results of experiments in 1930 were published in Burma Forest Bulletin No. 24 and these were followed by experiments at 3 Centres in 1932, at 11 Centres in 1933, and at 5 Centres in 1934.

Success in 1934 was moderate only but the design of the experiment was improved over previous years and an account may therefore be of interest.

2. In Lower Burma the monsoon breaks between the 15th and 25th May, sometimes earlier, but rarely later and is always well-set by the end of the month. June and July are nearly always consistently wet. Germination of teak seed proceeds throughout June

and is generally complete by the end of that month. Complete early germination, *i.e.*, by the end of May, might result in higher casualties but at least a fortnight's growing time would have been gained. Furthermore, germination being spread over a shorter period would give an evener crop.

Teak seed in Burma is either sown direct at stake or in small nurseries scattered over the area to be planted. In neither case is watering practicable after sowing, so that complete germination much before the rains break would be a disaster rather than an advantage. Ideally the seed should be prepared up to a point only before sowing and the monsoon proper should give the final impetus to germination. The method of preparation adopted must be simple enough to be carried out in the ordinary routine of *taungya* work.

To be satisfactory the treatment selected must be under control so that the correct dose can first be worked out and then some margin left for possible delays in the break of the monsoon. Burying the seed in pits and watering it for a fixed number of days, for instance, may produce magnificent results one year, premature germination and heavy casualties the next year and practically no results the third. The method for Burma is too prone to outside influences, *e.g.*, the degree of white-ant attack, the particular condition of the soil or drainage, or the interpretation of the orders by the executive.

3. Of the various methods tried in 1933, one known as the 1·114 method gave consistently good results at all centres and for several modifications as to length of treatment.

This method consisted in soaking the seed for twelve hours and then spreading it out to dry for forty-eight hours, the operation being repeated several times and the seed sown in nurseries or at stake just before the rains were expected to break.

This method is also less liable to be affected by outside influences than any of the others tried and was therefore chosen for repetition in 1934.

4. In 1934, experiment was made at 5 centres, Kunsan (Zigon), Nyaungbinzin (Tharrawaddy), Myohla (Toungoo), Kaing (Pyinmana),

and Natchaung (Ataran) and confined to the following :—

A	Treatment 1·114	.. Unworked nursery bed.
B	Divisional Treatment	.. Unworked nursery bed.
C	Treatment 1·114	.. Bed worked to depth 6 ins.
D	Divisional Treatment	.. Bed worked to depth 6 ins.

Altogether 24 nurseries were put down. There were eight at Kunsan, six at Nyaungbinzin, two at Myohla, four at Kaing and four at Natchaung.

The 1·114 treatment began on the 1st May at 6 P.M. and ended on 14th May at 6 A.M. Alternate soaking and drying was repeated 5 times. The Divisional Treatment consisted of exposure in heaps in the *ya* soon after the fire. All seed was sown on the 14th May. Counts were ordered for 25th May, 1st June, 10th June, and 30th June.

5. The experiment was improved, as compared with the previous year, in the following respects :—

(*a*) More careful sampling.

(*b*) Several nurseries from same sample. Each nursery of level quality throughout and laid out Latin Square chess-board.

A	B	C	D
C	D	A	B
D	C	B	A
B	A	D	C

All beds same dimensions. Same spacing between fruits and between beds.

(*c*) The layout allowed the experimental error to be worked out (for method, see pages 63—66, Volume I, Silvicultural Research Manual).

Note.—It was found that in an ordinary *taungya* it was usually possible to get evenly burnt spaces for nurseries up to 20 ft. by 20 ft. free from bamboo clumps or tree stumps. This size was therefore fixed giving 16 beds each 3 ft. by 3 ft. with sufficient space between beds. One hundred seeds went to each bed sown 10 by 10 at 3 ins. intervals. Where the country was too hilly to get 20 ft. by 20 ft. nurseries, 16 ft.

by 16 ft. nurseries were used and the number of seeds to a bed reduced to 50.

6. The experiment suffered from the late monsoon as, except at Natchaung, the seed lay in the nursery 8 to 9 days after treatment without rain. Germination was late and consequently the dates fixed for recording germination proved unsuitable and counts needed on 15th and 20th June were not made. A count every 5 days until germination was fairly complete would have been better.

It seems likely that the treatment given was insufficient and could have been continued with advantage another week before sowing.

7. Of the general arrangements possible criticisms are :—

(*a*) No note was made of casualty except at Kunsan and Natchaung. Casualties were of no consequence in either case, but the treatments were only moderately successful in forcing germination. A very successful treatment might result in high casualty and record of casualty is probably advisable in future.

(*b*) Except at Myohla, where only large fruit was used, no form of selection was allowed beyond the discarding at the start of obviously defective fruit. Since *experiment shows that germinative capacity varies with the size of the fruit, some grading by size *may* be advisable in future experiments.

8. Except when there were known differences between nurseries, the results from nurseries at each centre were added together bed by bed and the sum analysed. Agreement to this was first obtained from an authority on statistics in Rangoon.

Only differences between treatment-means exceeding 3 times the experimental error were accepted as significant.

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*Separate experiments carried out at these 3 centres in 1934 with different sizes of fruits indicated that much higher percentage germination was to be expected from large fruit than from small fruit.

9. Results may be summarised as follows :—

Except at Nyaungbinzin which favoured the Divisional Treatment, significantly earlier germination was obtained everywhere from 1·114 than from simple exposure. Working the soil of the nursery did not usually affect early germination but improved final germination slightly. Difference between high—and low—ground nurseries uncertain.

Except at Natchaung the monsoon was late and did not break till about the 22nd May. Only at Natchaung would the earlier germination obtained have repaid the trouble of treating the seed. Elsewhere the differences, though significant in the mathematical sense, were actually small.

The fact that there were for the most part small differences in favour of 1·114 is however important as last year's favourable opinion of this method is now confirmed by an experiment in which errors of sampling have been as far as possible eliminated.

Again, except at Natchaung, the seed was sown in nurseries 8 or 9 days before the rains broke and germination was late. At most centres germination did not begin till about the 10th June. This suggests that all treatments were insufficient. At many centres last year the best results were got from the 1·114 treatment started on the 25th April or 1st May, and continued till 20th May—the monsoon breaking immediately after sowing in nurseries.

It is considered therefore that good results should be got from the 1·114 method started about the 1st May and continued until the rains are about to break, the seed being then sown either in worked or unworked nursery beds.

10. The Natchaung results are given below in tabular form. The figures in brackets give the percentage germination. Where any treatment or treatments are significantly better than the remainder they are underlined.

NATCHAUNG.

Four nurseries—Nos. 1 and 2 on flat ground and Nos. 3 and 4 on saddle and slight slope. Results kept separate.

Date survival counted.	Mean germinations per treatment. A.	B.	C.	D.	Experimental error. E.	E x 3	Remarks.
25-5-34	49·3 (24·6)	26·8 (13·4)	52·3 (26·1)	28·5 (14·3)	±4·2	12·6	On flat.
	58·8 (29·4)	31·0 (15·5)	58·8 (29·4)	31·3 (15·6)	±4·7	14·1	On high ground.
1-6-34	83·0 (41·5)	53·3 (26·6)	77·0 (38·5)	71·8 (35·9)	±3·7	11·1	On flat.
	96·5 (48·3)	82·3 (41·1)	99·8 (49·9)	88·3 (44·1)	±2·1	6·3	On high ground.
10-6-34	84·5 (42·3)	60·0 (30·0)	83·3 (41·6)	80·5 (40·3)	±3·7	11·1	On flat.
	97·8 (48·9)	90·0 (45·0)	103·5 (51·8)	97·0 (48·5)	±0·8	2·4	On high ground.
30-6-34	84·3 (42·1)	65·0 (32·5)	85·5 (42·8)	87·5 (43·8)	±3·6	10·8	On flat.
	98·5 (49·3)	97·3 (48·6)	104·5 (52·3)	108·0 (54·0)	±1·5	4·5	On high ground.
Numbers of pairs of leaves. Totals and averages per plant							
30-6-34	387 4·6	278·5 4·3	390·8 4·6	389 4·5	±17·6	52·8	On flat.
	431·8 4·4	389·8 4·0	470 4·5	452 4·2	±10·2	31·6	On high ground.

Good early germination. 1·114 best irrespective of whether soil worked or not. For later dates 1·114 advantage maintained but some advantage from soil working also evident. Germination on higher ground than on flat throughout.

THEIR MAJESTIES' SILVER JUBILEE CELEBRATIONS IN THE OUTPOSTS OF THE EMPIRE.

BY G. R. H.-G.

This sounds a grand title, but what it really means is noise, noise, and yet more noise.

In a remote corner of the Himalayas the day began with the sound of village bands coming up the valley, bringing their local gods.

Each god is carried on poles and decorously draped, with curtains, palanquin fashion with a fringed canopy over head and when it is uncovered one sees fancy masks of brass and silver hung around with scarves and garlands. A horse-hair switch waved over it by an attendant keeps it free from flies.

The band which always accompanies it consists mainly of drums, loud harsh sounding instruments, beaten with sticks in different measures to produce a rhythmical medley of sound. It was these drums which caused our ears to suffer so unmercifully and after sitting in their midst for two hours while they were worked up into a crescendo of frightfulness, we could still hear them in our brains and in our dreams far into the night.

Three of these bands arrived with their gods during the morning and were entertained to a free communal meal so that by the afternoon they were in good spirits and ready to enjoy the celebrations.

We took our seats of honour in the midst of a large crowd. The men on one side and the women, rather shy and retiring, on the other side, all dressed in their best, smelly, dirty but very happy and excited.

Before us the band were seated on the ground and round them the young men formed a semi-circle. They each held something in their raised right hand (sword, a fan or a dirty cloth), and solemnly they began to sing and dance moving round in the circle with small rhythmical steps, the gods meanwhile being "danced" up and down by their bearers and occasionally being bowed over sideways to the other performers. The women were persuaded to dance also; in the same formation but quite apart; waving their arms gracefully, singing and laughing as they glanced across at the men.

The "melody" was produced by two or three short trumpets played upon ferociously and exhaustingly by practised performers, who broke off occasionally for a grateful puff at a communal cigarette which was being surreptitiously passed round.

There was also a stalwart with a brass bassoon as long as himself; it was so unwieldy that he could only raise it occasionally by supporting his elbow on his hip, and after levering it up into a horizontal position he would blow despairingly into it producing a blare like an asthmatic buffalo, and then lay it down again with relief.

We were presented with gifts from each god, garlands and scarves touched and sanctified by their holinesses, who bowed their approval while the bands increased their fury.

After enduring this for two hours I was told that the only way we could depart with honour was to say a few words and present our gifts of money to the gods. I rose and the bands were silenced. However, when I began to speak, my voice was drowned by shouts of approval and my words were repeated by all and sundry so that I do not really know what I did say, except that we all agreed we had enjoyed the celebrations very much, and

God save the King.

PRIZE DAY AT THE BURMA FOREST SCHOOL.

The annual prize distribution at the Burma Forest School took place on April 30th, 1935, before a large gathering in the Main Hall. Among those on the platform with the Director (G. D. Warwick) were the Board of Control consisting of the Chief Conservator of Forests (S. F. Hopwood); the Director of Public Instruction (P. B. Quinlan); the Conservator, Utilization Circle (C. H. Philipp); the Conservator, Working Plans (R. Unwin); the Divisional Forest Officer, North Toungoo Division (H. H. C. Pudden) and the Divisional Forest Officer, Yamethin Division (Thein Lwin).

The Director opened the proceedings with an address in the course of which he drew attention to the fact that the School had inhabited the present buildings for 25 years and had trained 681 forest officers. He hoped that economic conditions would soon

improve so that the courses could be restored to their full strength, the number passing out this year consisting only of 22 Vernacular men leaving one small Vernacular Class in residence.

The Director commented briefly on the year's work, a full report on which had already been considered by the Board of Control. He emphasised the fact that the greater part of the year had been spent in practical training in the forest during which a considerable amount of useful work was done for the local forest division. Health had been good and the "sports" side of the training, a valuable constituent, had not been neglected although depleted numbers had prevented the School teams from distinguishing themselves.

After presenting the certificates and medals the Chief Conservator expressed his satisfaction with the progress made at the School especially in the direction of physical and disciplinary training. He also drew attention to the very gratifying interest which the School Museum had evoked in the Province as exemplified by the large and increasing number of visitors who came to see it. He then addressed the students as to their future conduct after leaving the School, advising them to continue their studies in the forest and above all to keep up their pride in the School and its reputation by resisting temptation and by maintaining a high standard of fair-dealing, honesty and loyalty.

The Director of Public Instruction followed with further advice and encouragement, pointing out that those pursuing a career in the Forest were much to be envied. He warned the outgoing students that their studies should not end with the training course they had just completed, but that they should utilise their leisure hours to make themselves more efficient by reading. He also laid stress on the great value of a hobby.

At the close of the proceedings the visitors inspected some of the work of the students and also went over the buildings, refreshments being served in one of the lecture rooms. Later in the day a Pagal Gymkhana was held on the School recreation ground where the staff were "At Home" to their guests. At night a Burmese dancing troup engaged by the students entertained a large assembly of the local inhabitants.

EXTRACTS.

MUSHROOMS.

BY W. M. WARE, M.SC.

It is probably true to say that science, in relation to the art of agriculture and horticulture, advances in three stages. Being the younger, it has first to learn the established practice of the farmer or the gardener in any particular branch. Secondly, it may draw level with and even explain the methods of the practical man; but the third stage, *viz.*, that of actually guiding, comes always last of all and usually only when the relationship between science and practice has been long sustained.

Many branches of horticulture, as everyone knows, can present great difficulties to the practical man, and it is then that science is particularly useful; sometimes, however, it may be added, its help is neither welcomed nor afterwards appreciated.

In the cultivation of Mushrooms, with which we are now concerned, it will be agreed that, while the practice is as old as any, there have been few opportunities for an outsider to learn the established practice because of the secrecy preserved. The grower of Mushrooms has jealously guarded his slight knowledge and shrouded the process in such mystery that he appears now to stand aloof and be completely isolated. The result of this reticence, maintained for generations, is that, when some difficulty presents itself, these most secret growers are actually behindhand in their knowledge, and are coming into the open to bewail the fact that nothing is known about such things as substitutes for stable manure or how to stop the ravages of a certain mite.

It is consequently unfortunate that the newcomers, at a time when the Mushroom-growing industry in this country has room for expansion, should find but little help at hand when they desire to progress or to overcome difficulties.

The present account of Mushroom-growing, it may be stated immediately, is largely founded upon information provided by growers of experience, as well as upon some personal acquaintance with the practice. From this it is apparent that not all Mushroom growers are so secretive as many have been inferred, and full acknowledgment is made to those who have not only discussed the known details of the art but also have pointed out where information is lacking. The veil of secrecy has been lifted, and it is at once revealed that to grow Mushrooms successfully both skill and close attention to detail are necessary. A guide to the methods to be employed and a survey of the whole subject has already been published by the Ministry of Agriculture and Fisheries in their Bulletin 34, and in the space now available it is possible only to give a short account and to touch upon certain features of special importance or interest.

The first of these is undoubtedly the recent expansion of the industry in England. This is attributed to the duty of 8*d*. per lb. placed on imported Mushrooms, it being estimated that imports of Mushrooms to the value of at least £500,000 per annum are being replaced on the market by home-grown supplies—a replacement which provides a great opportunity for the British grower. The industry, however, both

in England and on the Continent, is a very old one, and has been most famous in proximity to some of the capitals, *e.g.*, Paris, Vienna, and London. In the United States, although established later, it has made great strides, and at the present time the most authoritative information comes from that country.

The commercial cultivation of Mushrooms is carried out entirely by means of specially prepared beds of composted stable manure, and meadow-growing, which has received public attention after one particularly good summer, is not here considered because the season is short and conditions are out of the grower's control. Manure for the beds must be carefully chosen. It should be fresh stable manure, stored in a place free from washing by rain ; it should be from cornfed horses and should contain plenty of straw litter. If straw is lacking, more can be added when the heap is first made up for composting. Owing to the very rapid rate of decomposition, the softer straws are to be avoided and wheat or rye straw preferred. The state of the manure when it arrives on a grower's premises varies greatly and its subsequent management must consequently also vary. Much depends on the source of supply, and perhaps the farmer who can store up and accumulate a heap of manure from his own stables is in the most favourable position—he can order the making of the compost from the very beginning. Other growers obtain supplies from towns or from cavalry barracks or racing stables, and this manure arrives on occasions after an unknown series of treatments ; it must be dealt with in the way best suited to its condition.

The first step is to build up a heap of any convenient length, about 5 feet high and 6 feet wide, flat at the top and with vertical sides. This heap, except perhaps in a dry summer, must be made under a shed with roof but with little side protection. All these requirements are directed towards securing an even fermentation of the heap. At the start, the moisture-content must be accurately judged and, except in the case of certain manure obtained from town contractors, a small quantity of water is applied with the rose of a water-can to make all the manure moist, as it is thrown up in making the heap. Dry patches require special attention. In summer, watering can be done more freely than in winter, but at all times great care is needed not to make the heap too wet. Pressure on the heap should be avoided—tight packing prevents correct fermentation. Heating and steaming of the heap should begin within a day or two : if after several days the manure is still cold, the condition can sometimes be rectified if the cause can be found. Thus, for example, lack of moisture will prevent heating. After about a week the heap is turned ; for this purpose two men are usually employed and with forks they throw the manure back from one end of the old heap and so start a new one. Great care is taken to place all manure from the outside of the old heap into the centre of the new ; watering of dry patches is carried out when required, and all cohering lumps are well shaken out. The new heap is built up with sides as vertical as possible, but when doing this the compost should not be beaten into position.

Further turnings are given at intervals of three or four days : the number of turnings varies from two to seven and depends on the rate of decomposition of the manure. A period of about three weeks is usually sufficient, and the condition

of the compost is judged to be correct if it is dark brown in colour and possesses a sweet and quite unoffensive smell. It should be tested by taking from inside the heap a long double handful which is "sheared off" by twisting the hands in opposite directions; if it is too tough to shear easily, the compost is not ready and the heap should be turned once more. The correct moisture-content is estimated by firmly squeezing a handful; the compost should become compressed by the fingers but drops of liquid should not be exuded and the palm of the hand should be found only just moist and certainly not wet. If a handful be squeezed close to the ear, a wet condition is revealed by the sound of squelching or bubbling. Full attention has been paid to the preparation of the manure, for it must be emphasized that the condition of the medium on which Mushrooms are to be grown is of the greatest importance, many of the failures experienced being traceable to wrongly made compost.

The beds may be of the flat or ridge type. Flat beds are of such a width that picking can be done on any part without inconvenience, and they are usually 6 to 10 inches deep. They are used for indoor work, on the floor or on shelving. Ridge beds are commonly 2½ feet at the base ; they have sloping sides and are about 2 feet high. This type is employed for out-of-door growing ; for indoor use the ridges are made slightly smaller. In constructing the beds, the manure is pressed firmly while it is still steaming hot, the amount of pressure depending on the moisture present. If in correct condition, the beds may be trodden, but if rather too wet they should only be beaten down with a fork. After making the beds, their temperature should be watched—it will probably rise to about 140° F., but after a week or ten days it will steadily fall. Often a vigorous growth of moulds appears on the surface, but it seldom does harm. It indicates fully moist conditions and can be stopped if desired by providing good ventilation to dry the surface. When the temperature is on the downward grade and has reached 70° F. it is safe to plant the spawn. Fragments of spawn are inserted in the manure just below the surface ; they may be as small as a walnut, but it is preferable to employ rather larger pieces, of about the size of a hen's egg. These are planted in rows at about one foot spacing.

After ten days, if the temperature of the beds is near 60° F., growth of mycelium from the edges of the spawn-fragments becomes apparent by a white fluffy development of hyphæ. The mycelium gradually spreads on the nearest pieces of straw which are covered with the white hyphæ, their dark brown colour becoming changed to a lighter tint. Outdoor beds must be covered with a thick layer of straw from the time they are made, this being removed and replaced at every operation. Indoor beds need not be covered with litter except in places with a heated and dry atmosphere or in draughty buildings, where its chief function is to prevent drying of the manure. In very cold conditions the litter helps to preserve some warmth in the beds, but it must never be imagined that the compost is actually a hotbed ; in reality the beds are seldom warmer than the air of the building. When by inspection it has been found that growth of the spawn is taking place, the beds are cased. This consists of applying 1½ inch of soil to the surface of the manure, the earth being just moist enough to be beaten down firmly with a spade to make a porous, level

covering. On premises long used for Mushroom-growing or where digging space is limited, it is advisable to use subsoil in order to avoid the occurrence of a fungus disease of Mushrooms known as "Bubbles" and caused by *Mycogne perniciosa.* Casing ridge beds is an art best learned by experience. After casing, the covering of litter may be replaced if thought necessary, but in most indoor places it can be dispensed with.

A period of waiting for the crop to appear now follows, during which it is only needful to see that the casing soil does not become too dry. It is best to maintain a condition of dampness, but the casing should never be made wet. In buildings where controlled heating is available, the temperature before the crop appears may be profitably kept between 60° F. and 65° F. provided that the beds are not allowed to dry out. With this temperature, a thin covering of moist litter is useful. In cold, unheated buildings the period of waiting for the crop may be as long as five months, but in warm conditions it may be reduced to five weeks.

When the first Mushrooms appear, the amount of watering may be increased slightly. It is most important to realize that the watering is to maintain a certain degree of moisture in the casing soil and should never be so heavy as to penetrate to the manure beneath. At all times it is beneficial and advisable to keep the pathways and walls in a moist state so that, by evaporation, some moisture is always available for humidifying the atmosphere.

The types of buildings used for Mushroom-growing are numerous and variable and certain conditions are peculiar to each one. It is impossible here to deal with the management of the beds in all the different circumstances met with in farm buildings, caves, special Mushroom houses, frames, and glass-houses. During cropping, the optimum temperature is about 55° F. Between 50° and 55° the Mushroom growth is comparatively slow, but the best quality is produced and there is less liability to attack by insect pests and fungus diseases. Between 55° and 60° a more rapid development of the Mushrooms is secured, and probably most commercial growers keep the air temperature between these limits. There is a possibility that strains of Mushrooms vary slightly in their temperature requirements, but the chief reason for the employment of this higher range of temperature is that the total crop which the beds are capable of producing will be gathered in a shorter space of time. The duration of cropping depends mainly on the temperature; it may be more than six months where 55° F. is not exceeded, as in caves, but is more commonly 2 to 3 months where the temperature is liable to rise as high as 70° F.

Between 60° and 70° F. cropping may continue satisfactorily if the humidity can be maintained, and although there is reason to believe that some Mushroom strains will thrive in this heat, it is certainly inadvisable to run up the temperature purposely. During summer, of course, it is unavoidable. The heating of Mushroom-houses is usually by means of hot-water pipes, which should preferably be kept clear of the beds both on account of the difficulty they present when the time comes to remove the old compost and also on account of the drying effect they have when in proximity. Oil stoves should not be used in houses during cropping unless the

fumes can be caused to escape by a special pipe. Mushrooms are very susceptible to mineral oil or its fumes, and it is found that under this influence deformities result, and mis-shapen gills are formed on the upper surface of the caps.

Picking should be done frequently and no Mushrooms should be left on the beds in the fully mature condition. The picking is done with a turning and twisting movement, and all stumps are later removed by digging them out of the casing soil, the holes being filled up with fresh earth. Buttons, cups, and broilers are graded separately and Mushrooms of different colours are not placed in the same basket. It is usual to pack them with the gills upwards to prevent discoloration of the lower layers.

Unfortunately Mushroom-growing is not without its difficulties, and, like other crop plants, the Mushroom is liable to be attacked by both fungus parasites and insect pests. The commonest parasitic fungus disease is known as "Bubbles," on account of the drops of liquid which appear on the very much deformed Mushrooms. This is caused by *Mycogone perniciosa*, a fungus which is now believed to be brought into the Mushroom house in the casing soil. To avoid it, care should be taken to dig soil which has not been used for cultivation, or to use subsoil. In places where there is a danger of digging as casing soil any earth which may have been contaminated with former Mushroom-bed material, even many years previously, and where it is impossible to avoid using it, a method of heating the soil is recommended, for it is known that the fungus cannot withstand 50° C. (= 122° F.) for even one hour.

In addition to this preventive measure, the strictest cleanliness should always be maintained in and around the Mushroom houses. If once the disease becomes established it is difficult to eradicate and can only be dealt with by measures of sanitation. *Verticillium malthousei* and *Cephalosporium constantinii* are two further fungi both of which are capable of causing deformity of the Mushroom. *Cephalosporium lamellaecola* forms a white cobweb-like growth on the gills but does not affect other parts of the Mushroom. One other disease remains to be mentioned; this is caused by a bacterial parasite, *Bacterium tolaasi*, which affects the upper surface of the caps and causes brown blotches. The origin of the bacteria is not known, but observation has shown that they usually attack under conditions of ample moisture, the discoloration being found, for example, most commonly at the place of contact of Mushrooms when they are growing in clumps. As a method of control it is suggested that, after each sprinkling or watering, the ventilators and doors should be opened with the object of drying the surface of the Mushrooms, but not for so long as to dry the casing soil or pathways.

Some fungi, though not actually parasitic, can cause great loss through their invasion of the beds. Wherever they grow in quantity the Mushroom mycelium is restricted in its spread and the crop is as a rule reduced. The White Plaster Mould, *Monilia fimicola*, is perhaps the commonest; it forms large white, almost dusty, patches in the compost, and resembles a deposit of powdered chalk or plaster. The Mushroom-bed Sclerotium, *Xylaria vaporaria*, is another invader of frequent occurrence. Its white mycelium fills the manure of the beds, and its resting or sclerotial

stage is found in the casing soil in the form of black fleshy bodies which are frequently branched and fused together in tangled masses which can be removed in handfuls. A third invader of the beds is a white toadstool (*Clitocybe dealbata*) which grows in large clumps and is recognized by its peculiar smell, its pale whitish gills, and its wavy-edged caps.

The fungi parasitic on Mushrooms, as every grower knows, are to be regarded as a serious danger, and, immediately their attacks are recognized, advice should be sought from this Society or from the Advisory Mycologist stationed in the area. With further information gained on the occurrence of the various diseases, after proper identification, knowledge of the life-history of the fungi causing them will accumulate, and consequently improved ideas on methods of control.

Pests of the Mushroom crop are numerous and all too common, and require continuous vigilance and immediate measures of control on the part of the grower. The larvae of either the Phorid or Sciara flies, or of the Cecid midges, are met with in nearly every Mushroom house, while springtails, mites, and wood-lice are not infrequently the cause of damage. Among the larger pests which cannot be disregarded are slugs, mice, rats, and moles.

In conclusion it may be said that in spite of this very formidable array of diseases and pests, the Mushroom crop is not only continuing to be grown but it is grown on an increasing scale year by year, and it is remarkable that those who once begin are completely taken up by their interest, apart from possible financial returns, in the true art with which they are concerned.

(*Journal of the Royal Horticultural Society*, July 1934.)

TALK ON PRESERVATION OF WILD LIFE.
PREPARED BY Mr. SHEBBEARE AND DELIVERED BY Mr. MEIKLEJOHN ON THE 15th APRIL 1935.

Some of you may have read in the papers the accounts of a conference held in Delhi, at the end of last January, about the Preservation of Wild Life. It may interest you to hear something more of it—what it was all about and what suggestions were made there.

The idea of preserving wild birds and animals is not, of course, an altogether new one, but it is one that has come into the limelight recently. I must not take it for granted that everybody who is listening to me is convinced of any necessity for preserving wild life and I had better begun by telling you the objects of the numerous wild life preservation societies that have sprung up all over the world.

The best way for me to do this is to quote the objects laid down by one of these societies—the one that aims at preserving wild life throughout the British Empire. They are as follows :—

1. The main object of the society is to ensure that no more species of wild animals shall be exterminated within the British Empire.

2. It considers that this can be best effected by the creation of a strong public opinion on the subject both at home and abroad, by furthering the formation of

National Parks and permanent sanctuaries, and by enforcing suitable Game Laws and Regulations.

3. It believes that practical steps can be taken by which every species of wild life can be preserved, without hampering in the slightest the economic development and civilization of our territories.

4. It is no part of the aim of the Society to preserve animal life to the detriment of human industry, or the natural development of mankind ; nor does it offer any opposition to the fair and legitimate pursuit of sport.

This last sentence shows that the society, like most reasonable people, does not disapprove of fair sport. Sport is generally the foundation on which a love of wild life is built and, what is more, it is mainly sport on which we shall have to depend for the sinews of war, in our struggle against the wanton destruction of wild animals.

Mankind has waged war on wild animals from the very earliest times. At first, as a hunter, he killed whatever would serve him for food, as well as the beasts of prey that would otherwise have killed *him*. Later, when he had discovered the secrets of agriculture and the domestication of animals, he became a farmer and stock-breeder and, no doubt, killed the grazing animals that ate his crops as well as the carnivorous ones that ate his cattle.

Naturally, with a history like that behind us, we are all of us born with the hunting instinct more or less strongly developed and this, to my mind, is all to the good. It is all a part of the love of nature, for you cannot help noticing that those who love nature most, and are the keenest on its preservation, are the very ones in whom this sporting instinct is most strongly developed—those, in fact, who, in their youth first displayed their love of wild life by their energy in trying to kill it.

It was all very well for man to kill whatever he could indiscriminately in his early, savage days when he was poorly armed and engaged in a constant struggle against wild nature. As his armoury improved, particularly when firearms were invented, the odds became heavier and heavier against the animals, and man had to begin to handicap himself by means of game laws and close seasons. All the modern inventions, the motor-car and aeroplane, the spot-light and electric torch, demand further restrictions to preserve the balance between the number of animals killed and the natural increase in the stock of game.

No sportsman objects to such reasonable restrictions made in the interest of the game, though, of course, opinions may differ as to what is reasonable and what is not. The true sportsman is more interested in the increase of game in his own neighbourhood than in a heavy individual bag. It is for this reason that I believe that the Shooting and Fishing Clubs of Northern Bengal will become the backbone of any scheme for the preservation of wild life in Bengal. These clubs, since they have leased the fishing and shooting in the Reserved Forests, have imposed restrictions on themselves in the interests of the game.

Of course, the Shooting and Fishing Clubs are really only concerned with the protection of those birds, beasts and fishes that are considered game, though, in practice, they extend their protection to all wild things. Wild Life Preservation

Societies are not only interested in game, but in all kinds of wild life, as well as wild vegetation and scenery. They also interest themselves in the foundation of what are known as National Wild Life Parks.

In all parts of the World nations are making sanctuaries to preserve their wild animals and natural vegetation, which they now regard as a national heritage. In these National Parks Nature is left to herself, and sightseers, besides enjoying the scenery, can watch the birds and animals in their natural surroundings.

In such places wild animals lose all fear of mankind in an unbelievably short time. Visitors can feed wild black bears from their motor-cars in the National Parks of North America and watch lions at close quarters and without danger in the Kruger National Park in South Africa. One of the most thrilling sights in the World is to see out of the train window as you steam across the Athi Plains in East Africa the enormous herds of antelope and zebra, with occasional groups of giraffe and to walk almost among the zebra, wildebeeste, kongoni and gazelles, on the golf-course at Nairobi. There are sanctuaries nearer home in Burma and Assam and a newly established one in the United Provinces. One is almost tempted to hope that it may one day be possible to feed our Bengal rhinoceros on carrots!

More and more people every year are in a position to spend their holidays in sightseeing and, with the improved transport of the future, Wild Life Parks will become the great rival of mountain scenery and ancient monuments as an attraction for sight-seers. It will not be long before the countries that possess such attractions will reckon themselves lucky.

Another sign of the times is the way in which the sportsman traveller who, ten years ago, was mainly a collector of trophies has given up the rifle for the camera—an example set by the Prince of Wales. Every year more books on Wild animals and birds are written by men who have watched them in their native haunts, and these are illustrated with the most beautiful and intimate photographs in a "home setting." "Movie" and "still" photography is becoming yearly easier for the amateur, particularly that most fascinating hobby, flashlight traps. A camera is set up in the jungle alongside a game-path or over a tiger's kill, and the animal is made to take its own portrait.

I seem to have drifted away from my principal subject—the Wild Life Conference at Delhi. The idea of holding this conference originated with a small group of enthusiasts—sportsmen and nature-lovers—who were distressed to see the wholesale destruction of wild birds and animals that is going on in almost every part of India, and at a steadily increasing rate. These men got in touch with as many others in all parts of India as they could, and proposed a meeting to see what could be done. The proposal came to the ears of the Government of India who, realizing at once the importance of the matter, not only offered its fullest support but undertook the whole organization of the conference. About sixty officials and non-officials representing Provinces and Indian States attended the conference, which lasted for three days.

The Preservation of Wild Life will be a matter for Provinces and States under the new constitution, and not for the Central Covernment, which will pass cn the

resolutions with their recommendations. It will then be up to Local Governments to show what they can do to remedy the present deplorable state of affairs.

This is not going to be an easy matter. It is not merely a question of making laws to control the destruction of wild birds and animals, or of laying out sanctuaries to protect them. This is an important part of the work but it can never be effective unless it has the backing of public opinion. The formation of local wild life societies and the appointment of Honorary Game Wardens from among good sportsmen of influence are two good lines to work on.

Fortunately the whole attitude of mankind towards wild life has changed and is changing rapidly with the spread of education. The extent to which the British schoolboy has changed within one generation was well put by one of the speakers at the conference. Whereas, in his own schooldays, his interest in natural history had consisted mainly in birds-nesting, he found, when he went on leave, that his son, armed with a pair of field-glasses, really studied the habits of wild birds and animals. He thought that this was partly due to the excellent, and very cheap, natural history books that boys in England can now get, and partly to the lectures on natural history with lantern slides that they are given at school.

The conference recommended the drawing up of an All-India Convention for the preservation of wild life, on the lines of the African Convention of 1933. This would be a sort of agreement between the various States and Provinces to co-operate on certain definite lines. It also recommended that if the proposed Asiatic Conference is held, India should be represented.

The most important recommendation made was that all provinces and states should enact legislation for the preservation of the wild life in their territories. The old Wild Birds and Animals Preservation Act of 1912 has been practically a dead letter because offences under it are non-cognizable. A policeman who finds a poacher selling deer's meat in the close season can neither arrest the man nor seize the meat. All that he can do is to lodge a complaint with the nearest magistrate who can issue a summons. If the poacher fails to obey the summons the magistrate can order his arrest but, by that time, the meat will have been sold and eaten and the poacher will have departed for his home—often outside British Territory.

One of the most definite conclusions arrived at by the conference was that an effective way to stop the indiscriminate slaughter of wild animals is to prohibit, or at any rate to regulate the sale. All really serious destruction of wild life is brought about by those who kill for profit. The danger to our Bengal rhinoceros is the value of his horn. The scarcity of sambhur is due to the sale of meat. It is safe to say that, if the trade in game could be checked, the effect would be apparent in the country-side to the most casual observer within a year or two. The conference recommended that, if the sale of wild animals could not be prohibited entirely, it should be closely regulated.

The Delhi Conference will have done some good, if it has opened our eyes to what is happening to some of our wild birds and beasts, and shown us what ought to be done to protect them. But the conference was only in a position to recommend ; it remains for local governments to put the recommendations into operation with the help of

public opinion which will surely be behind them in any sane efforts to protect our wild life. Before an Asiatic Conference is called together I hope that we shall be in a position to show that India, and particularly Bengal, has done its share of the task.

THE INFLUENCE OF THE GROWING USE OF SUBSTITUTES FOR TIMBER UPON FOREST POLICY WITH SPECIAL REFERENCE TO BURMA.

By S. F. Hopwood, Chief Conservator of Forests, Burma.

Included in the provisional Agenda for the meeting of the Board of Forestry held in October 1934, there was no reference at all to the increasing employment of substitutes for wood in nearly all its uses. For the Forest Department in Burma, this increasing use of substitutes is a question of the very greatest importance and is a menace and a threat to Forestry as practised in the Province, though it is not only the Province of Burma which is affected in this way but all countries which are at all interested in the production of hardwoods. To devise measures for combating this menace is beyond all comparison by far the most important problem Forest Officers have to deal with to-day.

(*The following remarks apply mainly to hardwoods.* It is, generally speaking, *hardwoods* that are suffering from the introduction of substitutes.)

2. In "Forestry, An Economic Challenge," by Arthur Newton Pack (page 2), it is stated that "the use of practical substitutes for wood has been gradually decreasing our per capita consumption of lumber to a point almost half of what it used to be." This may be true for the United States of America; in Burma, although the increasing use of substitutes has not reduced the consumption of hardwoods to anything like the same extent, the use of teak and other hardwoods has been very much affected by the introduction of substitutes. Examples of this may be seen in the more advanced parts of the Province notably in the big towns. Till recently all the bridges on the roads between Rangoon and Mandalay and Rangoon and Prome were entirely constructed of wood. They have all been replaced by bridges of iron or reinforced concrete. Elsewhere in the world a wooden bridge is now a rarity.

3. Till recently, the oil fields of Burma used to consume very large quantities of timber in the construction of derricks, aqueducts and structures to carry pipe lines across streams. Nowadays these are all made of reinforced concrete. The Engineer knows that if he builds a structure of reinforced concrete, it will be in even better condition 100 years hence than on the day he built it and even in an oil field there is no danger from fire.

4. Formerly all houses in Rangoon were made of teak—roofs, floors and walls. It is exceptional to find timber used in the construction of houses nowadays. In Rangoon Government recently spent over Rs. 124 lakhs on the construction of the buildings for the Rangoon University—practically the only timber used on these buildings was the scaffolding. The buildings are all reinforced concrete and most of the floors are made of some composition. The fence posts round the whole estate are either iron or reinforced concrete. Some of the staircases and some of the bedroom floors are made of teak, but it can be said with truth that practically speaking no timber has been used in the construction of these buildings. (Even the window frames are of

metal.) The same is true with regard to other buildings which are being erected in Burma. This is partly due to Municipal bye-laws which prohibit the erection of wooden buildings inside Municipal limits. Elsewhere there is a reluctance to put up wooden buildings because insurance companies charge higher premiums. In the new offices for the Rangoon Port Trust, in the immense new wharves, in the new offices for the Irrawaddy Flotila Company and the new Bank buildings which have recently been constructed, almost the only timber employed has been used in the manufacture of the office furniture ; much of the office furniture is made of steel. The old barracks in Rangoon were entirely made of timber—roofs, walls and floors—in the new barracks timber is conspicuous by its absence. If this is going on in Burma where hardwoods are better and cheaper than anywhere else, there is no doubt that a similar increase in the use of substitutes is taking place all over the world.

5. The effect of recent railway accidents has been to discourage still further the use of wood in the manufacture of railway carriages. In Burma it has been found that the "sole bars" made of teak on the goods wagons of the Burma Railways are not equal to the strain. (Sole bars are beams of teak or metal running longitudinally on each side of the wagon.) These teak bars have been cracking and breaking with disquieting frequency and are suspected of having caused certain derailments. It has been decided to replace them all by steel in 4,400 wagons at a cost of Rs. 13 lakhs within the next 8 years.

6. It was noticed that the bridge decks of a cruiser of the Royal Navy which called at Rangoon were made not of teak but of Oregon pine.

7. In the remote districts in Upper Burma it apparently pays the Public Works Department to import concrete for the mile-stones, culverts, bridges, rest-house fences and rest-houses and rail it upwards of 500 miles rather than use the timber available on the spot.

Even the fence enclosing the whole of the Burma Forest School estate at Pyinmana is made of concrete.

I quote the following from the "*Timber Trades Journal*" of

July 4, 1934, written by a Member of the Division of Forest Products of the Australian Council of Scientific and Industrial Research :—

"Foresters who have had to look on, more or less helplessly, *while they see the forests ruthlessly exploited for present profit* and with little or no consideration for future supplies, have issued warning after warning of a future shortage. Justified though their attitude may have been, a study of timber utilisation to day indicates the need for a revision of this prediction.

......................The world's timber consumption per head of population has been steadily decreasing for a number of years. Any approach of a shortage will considerably assist in a further decrease because rising prices will result in an even greater use of timber substitutes than at present. This will always tend to check the price increase.

The use of steel window frames and doors, office fittings, poles, railway sleepers, railway carriages and numerous other articles previously made of timber is only one of the many causes of decreased consumption. Numerous types of fibre and plaster building boards have come on to the market and their manufacture and use are progressing at a tremendous rate. Still more recent has been the growth of the plastics industry and an increasing number of articles are now being pressed from moulding powders. The growth of this industry has been phenomenal, and it is only in its infancy. This factor of timber substitutes is one that was not foreseen when panic predictions were made."

8. The average annual import of teak into the United Kingdom in 1896 to 1900 was 63,000 loads, in 1905-1910, 49,000 loads, in 1926-1930, 43,500 loads, in 1931, 23,700 loads and in 1932, 16,500 loads. I here quote the report for 1932 of Sir Hugh Watson, Timber Adviser to the High Commissioner for India :—

"Imports of hardwoods from India fell from 19,600 tons in 1931 to 17,000 tons in 1932, owing to the drop in the imports of teak, a timber that has suffered badly from decreased shipbuilding *and substitution by cheaper timbers and other materials.*" It is largely due to the increasing use of substitutes that the average annual import of

teak into the United Kingdom fell from 43,500 loads of teak in 1926-30 to 16,500 loads in 1932. The fall had been progressive long before the slump set in.

9. What effect should this increasing use of substitutes have on our forest policy?

In endeavouring to answer this question it must be remembered that there is a very great difference between Burma and the other provinces of India. Burma is a timber-exporting country whereas India is a timber-importing country. If, in Burma, money is spent on plantations or works of improvement to increase the growing stock, it is not to produce timber for the internal requirements of the country; it is with the object of maintaining or increasing the exports of teak to other countries of the world, *i.e.*, it is purely a commercial proposition. During the last five years Burma has exported on the average 163,000 tons of teak to India and other countries. For the years 1925-1929 the amount was 234,000 tons. The amount exported has therefore dropped by about 71,000 tons per annum or a total of 355,000 (converted) tons in five years. In other words we have unwillingly retained in the Province some 355,000 tons in the last five years. The above large amounts of timber were all grown in natural forest. If we continue to make plantations or undertake works of improvement which should reduce working costs and cheapen teak, it is with the object of maintaining or increasing the amounts to be exported to India and other countries of the world.

10. It is to be hoped that the drop in the export of teak from Burma to India is temporary and due to the general slump in jute, cotton, tea, lac and other products. The natural increase in population in India may well increase the demand for Burma teak for many decades but the future price is extremely uncertain. Competition by substitutes will tend to lower the price at which Burma can sell; it is therefore impossible to forecast financial results and such forecasts are imperative in a commercial enterprise, otherwise it becomes a pure gamble. There is nothing to be said in favour of continuing the extensive planting of teak in Burma for export if it is

not a commercial money-paying proposition but only a financial gamble.

11. It is within the last few years that the menace of substitutes has increased so greatly. (From the point of view of the Forest Department in Burma "substitutes" include not only such materials as steel, concrete, *etc.*, but inferior timbers other than teak and from the point of view of the Forest Department in India the timbers from the Philippines and Siam which successfully compete with similar timber from the Andamans must also be regarded as "substitutes.") Even if the produce of our teak plantations was in any way comparable with the teak produced in our natural forest, are we justified in continuing to plant some 4,000 acres a year at a cost of several lakhs annually? If we were to continue planting at the present rate, taking the final yield at 50 tons per acre, we shall have increased our outturn when these plantations are mature by 200,000 tons of teak annually or 20 million tons in 100 years. Who will use all this teak? Improvements in the manufacture of substitutes may be noticed every day and by A. D. 2080, when these plantations are mature, substitutes will have improved out of all knowledge.

Plantations.

In certain reserved forests in Burma for which figures are available (area 16,000 square miles) as a result of enumerations there are now standing upwards of 4,000,000 *pyinkado* (*Xylia dolabriformis*) trees 6 feet in girth and over and in the remaining 19,000 square miles of reserved forests and 114,000 square miles of unclassed forests there are also vast supplies of mature *pyinkado*. Much of this area is classed as inaccessible, but if there was any demand for the timber, it would be extracted. We still continue to make plantations of *pyinkado* although last year we only planted 463 acres with this species.

12. In making these plantations we are not planting up barren areas, but we are destroying good natural forest in order to make the plantations and it frequently happens that the plantations are of less value than the forest which they have replaced, in Burma we have already made about 133,000 acres of plantations *plus* 14,268 acres written off as failures at a total cost of over Rs. 42,00,000. This

figure is the bare cost of planting and tending; it does not include any overhead charges such as the pay and pensions of the officers. Without these plantations a heavy reduction in staff would be possible. Over this area of 147,000 acres we have destroyed the natural growth consisting very largely of teak and bamboo forest and have replaced or attempted to replace it by pure teak.

13. It is not only our forest policy regarding making teak plantations that is affected by this preference for substitutes. In the Federated Shan States we have planted some 1,600 acres with *yemane* (*Gmelina arborea*) with the object of providing pitprops for the future needs of a big silver and lead mine. There is no guarantee that the mine will use these trees when they are mature as pitprops and it is now extremely unlikely that it will use them. The mine is already using steel. These plantations are not successful and all further planting here has been stopped. Latest reports indicate that owing to continued insect attack, these plantations will be shortly non-existent. The cost of these *yemane* plantations is over Rs. 4,50,000.

14. I am of opinion that we should face the facts, agreeable or otherwise. Continuity of supplies will be useless if the supplies are no longer saleable; I think that the attitude of many forest officers and timber traders in this connection is a wrong one. Early this year Mr. W. O. Woodward, Chairman of the Saw-milling and Wood-Working Section of the Timber Trades Federation, gave a lecture entitled "Timber and Its Substitutes." At the close of the lecture, Mr. E. P. Tetsal, President of the Federation, in a speech stated that "he had been particularly interested to come that evening because he hoped to hear something about substitutes, but it had been really shown that there were no substitutes." This attitude will not help us.

15. In the past one expected a Forest Officer to be conservative and to say that he was conservative was the highest praise. Nowadays it is essential that a Forest Officer must be adaptable. Where substitutes are of more utility and their use is economically justified, it is like trying to roll back the tides to endeavour to stop their use. I have been told in this connection that Resolution No. 1 on Forest Policy at the Third British Empire Forestry Conference held in Australia and New Zealand in 1928 must be accepted. This Resolution begins: "It is of paramount importance to lay down and adhere to a definite and permanent general policy." I do not agree. We must realise

that in Forestry, as in everything else, changes are constantly taking place and we must be prepared to meet the menace of substitutes by altering our policy. In Burma we have some 35,000 square miles of reserved forests; over a large part of this area the sound of the axe has never been heard. We have also some 114,000 square miles of unclassed forests. The relatively much larger area of natural forest in Burma compared with India affects the question of planting in Burma profoundly.

16. The increased use of substitutes must have a very great effect on our policy, as there is every reason to anticipate a decrease in demand for teak and other timber. Further, all timber-importing countries of the world are now setting their house in order in forestry matters and by A. D. 2080 when our plantations are mature there will be a very much smaller export demand for the hardwoods of Burma. After some sixty years of scientific Forest Management, the effect of the improvement of the forests and increased production of timber in the Provinces of India is already noticeable. In the Administration Report of the Forest Department of the Madras Presidency for the year ending 31st March 1934, it is stated: "It is gratifying to note that Government have issued instructions that all departments of Government which require timber should consult the Forest Utilization Officer. As a result of the above orders the Jail Department which hitherto had been mostly using Burma teak has placed several orders with the Forest Department."

The following tables are of interest :—

The total consumption of indigenous timbers other than teak used in Carriage and Wagon Shops in India during 1927-28 to 1932-33 was as follows :—

Total consumption of indigenous timbers other than teak used in Carriage and Wagon Shops in India.

		Tons, log.
1927-28	..	9,800 (29 per cent. of grand total)
1929-30	..	14,200 (31 per cent. of grand total)
1930-31	..	17,000 (40 per cent. of grand total)
1931-32	..	14,000 (48 per cent. of grand total)
1932-33	..	15,000 (54 per cent. of grand total)

and the total amount of timber consumed in Carriage and Wagon Shops was as follows :—

Year.		Tons. log.	Percentage of Total.	
			Burma teak.	Indian teak and indigenous timbers.
1927-28	..	34,000	69	31
1928-29	..	*Not available*	..	..
1929-30	..	45,000	57	43
1930-31	..	42,000	50	50
1931-32	..	29,000	40	60
1932-33	..	28,000	36	64

Last year over 657,900 tons of cement were consumed in India. A large firm is building a cement factory at Allanmyo on the river Irrawaddy. This cement will be very cheap, as there are abundant supplies of raw material and the power will be obtained by tapping reservoirs of natural gas.

17. The increase in the use of substitutes may have less influence on the forest policy of a timber-importing country than in the case of a timber-exporting country so far as questions regarding expenditure with the object of increasing the yield by means of plantations or works of improvement are concerned ; in fact it may be argued that an increased yield and the consequence of an increased yield, namely cheap timber, is the best method of combating substitutes.

18. In framing our Forest policy we must bear in mind that if any of our rules result in making the price of timber higher to the consumer, we are helping substitutes to win the battle and we must consider the necessity for retaining such rules. We must remember that (hardwood) timber is no longer a necessity—in most of its uses it is nowadays only a luxury—(though in India its chief rôle is that of a necessity between the mud and bamboo hut stage and the brick, stone and iron housing stage). After the War we envisaged the clear felling of our natural forests and the complete utilisation of the crop. We have seen how vain was the vision. We are much further removed from the complete utilisation of our crop now than we were immediately after the War.

19. In November 1933 the Conservator of Forests, Utilization Circle, Burma, wrote: "Substitutes are many and varied but there will always be a need for all the wood the forests of the world can permanently produce." In the past it has always been assumed that we shall be able to sell all we grow and that therefore we should grow as much as possible. Our whole policy has been based on this assumption and on the bogey of the coming timber famine which has been continually preached in the past.

One of the most obvious ways of reducing the price of timber is to lower the rates of royalty charged by Government.

Reduction in royalty rates.

20. As the Government of Burma was of the opinion that cheap teak means that more teak is used whereas dear teak makes the engineer consider the alternative of using steel, concrete or cheaper timber, it was recognised that the most direct way of making teak cheaper was to reduce the rates payable as royalty. Last year the royalty rates paid by all lessees were reduced 30 per cent.—"in order to assist the lessees *in maintaining the market for teak by lowering the price and placing it on a competitive basis*, the Government of Burma (Ministry of Forests) have decided to sanction the reduction by 30 per cent. of all royalty rates under long-term teak agreements." This 30 per cent. reduction in royalty last year cost the Burma Government the sum of Rs. 14,50,000. By the words "competitive basis" the Burma Government meant that teak by being reduced in price would be better able to compete with substitutes and other timbers.

21. It must be admitted that action has not been very consistent in this matter. While the royalty rates have been reduced in order to maintain the market for teak by lowering the price and placing it on a competitive basis, the outturn of teak has been very heavily reduced and the better qualities and grades have been artificially withheld; this can only have the effect of increase or maintenance of price and encouragement of substitutes. Between the years 1921 and 1931, 202,000 teak trees which ordinarily would have been girdled were not girdled. In the year 1933 the total reduction in the number of trees girdled was 103,700 and 112,600 in 1934. A great many of these

reductions are made at the request of the firms of teak lessees ; some of the firms are heavily in arrears with the extraction of girdled trees.

22. Any measures that have the effect of increasing the price of timber to the consumer must lead to an increased use of substitutes and although, from some points of view, a higher price for teak is very desirable, raising the price may have a disastrous effect.

23. The question of lowering the price of wood to compete with substitutes is vital and there are inconsistencies and dangers in the present position of Burma teak in this respect. Good quality teak is in danger of being withheld too much above the prices which the consumer is at present able to pay. If recovery is adequate, this policy may be justified but it can scarcely fail to encourage substitutes to some extent.

Timbers other than teak.

24. The royalty rates paid for timber other than teak have all been reduced some 20 per cent.

A royalty rate of Rs. 15 a ton on *pyinkado* in the round adds about 8 annas to the cost of each meter gauge sleeper. In the past the Burma Railways have imported metal sleepers in small quantities.

25. In 1928 for the whole of India there were 5,08,20,000 wooden sleepers and 3,64,70,000 metal sleepers whereas in 1932 wooden sleepers had increased in number by only 9,64,000 but metal sleepers had increased by 78,18,000.

26. Apart from high royalty rates there are other restrictions which are helping to win the battle for substitutes :—

Girth limits.

The forests in Burma are for the most part worked under the selection system and the minimum girth limits have in many cases been fixed quite arbitrarily by Working Plan Officers. Most of these minimum girths below which a tree may not be felled are very high. This is due to some confused idea that a high girth limit is necessary to ensure a sustained yield. These high girth limits increase the cost of extraction per ton and reduce the profits needlessly. For example although the Working Plan Officer laid down a minimum girth limit of 7 feet for teak in the Mawku Working Circle, Upper Chindwin Forest Division, the Conservator of Forests, Working Plans Circle, fixed the girth limit at

8 feet 6 inches. Girdling Officers kept a record of trees which, though they were 8′ 6″ in girth or over, were too unsound to girdle and it was found that no less than 48 per cent. of the trees which had reached the minimum girth limit could not be girdled because they would not yield a log. In addition, a very large proportion of the trees which were girdled were unsound. In most of the forests of Burma the minimum girth limit for teak is 7′ 6″ for moist forest and 6′ 6″ for dry forest. These limits are in general too high. Before teak reaches these limits it has usually begun to decay, as is evidenced to some extent by the fact that last year 78·3 per cent. of the logs extracted by the big firms of teak lessees (191,271 logs out of a total of 244,044) were classified as "refuse." The result of these high girth limits is not only that the timber is unsound but that a given area yields fewer trees and the cost of extraction is consequently heavier. Certain teak reserves are still being worked under a 10′ girth limit.

Teak is durable and floats and is exceptionally easy and cheap to extract so that the effect of a high girth limit for teak does not very appreciably raise the cost of extraction, though it does raise it to some extent. With *pyinkado* and other heavy woods a high girth limit has a much greater effect on the cost of extraction.

28. If the minimum girth limits for teak are high, those for timbers other than teak are much higher in proportion. It is not unusual to find that working plans prescribe a girth limit of 8 feet for *kanyin* (*Dipterocarpus alatus*) and a girth limit of 7′ 6″ for *pyinkado* (*Xylia dolabriformis*). For *in* (*Diptercarpus tuberculatus*) a girth limit of 7′ is frequently prescribed, but there is more than one instance of a 8′ girth limit for *in*. In the Pyinmana Division the Working Plan lays down a girth of 8′ for *pyinkado*, *kanyin*, *thingan* and *thingadu*, and for all other species 7 feet. Similarly the Insein Divisional Working Plan prescribes 8′ for *kanyin*, *kaunghmu* and *thingan* and 7′ for *pyinkado*, *pyinma* and *thitka*. One result of these high girth limits is that the ordinary trader finds that it is beyond the powers of his buffaloes to extract the big butt logs. Although if the girth of such logs exceeds 9′ the royalty charged is only 50 per cent. of the ordinary royalty rate, it frequently happens that even with this inducement

the trader is unable to extract the logs. It cannot be to the advantage of Government to grow the timber to this size with the result that Government only receives half rate of royalty. A girth limit of 8 feet means that extraction is the very reverse of concentrated.

28. It is not only in Burma that these high minimum girths prevail. In the Andaman Islands in selection fellings, the girth limits for *padauk* and *gurjan* (*kanyin*) are 9 feet, *white chuglam* 8 feet and others 7 feet and it may be that similar arbitrary high girths prevail elsewhere in India. In the case of the Andaman Islands it is estimated that *padauk* and *gurjan* require 120 years to reach 7 feet in girth and 150 years to reach 8 feet. To attain a girth of 9 feet they must therefore require at least 180 years. It is further estimated that in the case of *padauk* while growing from 7 feet to 8 feet, 5,443 trees will disappear and in the case of *gurjan* 9,886 trees. A girth limit of 9 feet for *padauk* and *gurjan* can only mean that a very large percentage of the growing stock is never reaped—to attempt to grow trees to 9 feet in girth instead of, say, 7 feet in girth means a very heavy loss in the following ways :—

Appendix I of a Note on a tour of Inspection in the forests of the Andaman Islands by C. G. Trevor, Inspector-General of Forests to the Government of India.

(1) Several thousand fewer trees reaped.

(2) Trees of 9 feet in girth and above are normally very much more liable to be decayed or to yield defective logs than trees of 7 feet in girth.

(3) Extraction work is less concentrated and consequently more expensive.

(4) A 9 feet girth limit does not mean that all the trees extracted will have a girth limit of 9 feet—a very large percentage will prove to be over 9 feet in girth. Logs of heavy hardwoods over 8 feet in girth cannot be extracted except from very accessible places and even from accessible places extraction of these large logs is only possible in very short lengths.

(5) A high girth limit means a long rotation and a long rotation means that we only get about two crops off the ground in the time taken to yield three or four if a low girth limit is employed.

At an Informal Conference of Forest Officers held at Maymyo on the 27th June 1934, it was unanimously resolved that "The revision of girth limits should be taken up at once and its effect studied in all its aspects both from silvicultural and utilization points of view. The object should eventually be to fix the limit at which trees begin to decay and beyond which it does not pay to grow them any longer. It will partly depend on the minimum size required on the market. When that limit has been fixed forest by forest the aim should be to remove all stock over that limit and get the forests into as healthy a condition as possible."

29. It has been suggested that if Burma is separated from India there should be a 25 per cent. import tax on teak imported from Burma into India. Mainly for the reason that such a tax would make teak timber very much more expensive to the consumer and he would thereby be driven to use substitutes, this suggestion to tax imports of teak must be resisted most strenuously.

30. (1) In the past a keen demand for timber has often been associated with gross waste of forest resources. Except where a strong Government Forest Department has controlled extraction strictly the timber trade has usually creamed the most profitable trees and logs without troubling about the future. This has been seen in America, India, Karenni, Siam and elsewhere. The first task of the Indian Forest Department, both in India and Burma, was to check the excessive extraction, creaming and waste in active progress. Much essential work has been done in this respect with good results. It is not suggested that this past policy was wrong but it is suggested that times have changed and a new policy is necessary. Whilst continuing to check destructive exploitation and waste of potential revenue the Forest Department must realize that in ordinary commercial forests to sell trees is as much a part of the duty of the Department as to grow them.

(2) Until recently the Department has usually had to act as a brake on a demand exceeding the supply. In the future the supply will in Burma exceed the demand.

(3) The teak trade itself is faced with this new situation. Teak

is an exceptionally good wood and in the past it has sold very easily and profitably. In future it will meet increasing competition and will probably have to improve in quality and come down in price to hold its own.

(4) The same remarks apply to other hardwoods. It behoves the Forest Department therefore to modify its traditional attitude towards the timber trader and help him to sell his wood instead of acting simply as a brake on his activities. The change can be made without sacrificing any vital principles. There is a happy mean between working a forest to destruction without thought of the future and conserving it by mistaken rules so onerous and vexatious that trade is hampered unnecessarily and markets are lost which could have been held.

Silviculture is a means to an end and normally that end is the sale of trees. Girth limits and regeneration rules should be considered at least as much in their bearing on Utilization as on Silviculture. Royalty rates are a double-edged weapon ; if too high they reduce the final volume of sales and hamper wood in competing with substitutes. Rules to prevent wasteful logging and extraction are good within reason but not if pushed too far. Our attitude towards the timber trader must be altered. The numerous irritating restrictions on the extraction of timber must be removed. At present in Burma no timber can be moved without a "removal pass" issued by a Forest Officer for each consignment. Licenses to extract timber and removal passes to move timber must be returned to the Forest Office. In one Forest Division fines were imposed in 91 cases in one year for non-return of time-expired licenses to extract timber. A very large proportion of the 11,978 forest offence cases last year consisted of very venial 'crimes' committed by timber traders. The ultimate effect of many of these penalties can only be to increase the price of timber to the consumer. In the past this did not matter very much, but conditions have changed considerably in the past few years. A check on major dishonesty and carelessness is essential but it is wrong to enforce such strict rules that good traders are discouraged from working and unnecessary expense is added to the production cost of timber reaching a market which is increasingly competitive,

CULTURE OF KUTH

PART II.*

GERMINATION, GROWTH, FLOWERING AND FRUITING.

BY SHER SINGH, M.SC.

Deputy Conservator of Forests, Ramban Division, Kashmir State.

Kuth seed shed in autumn begins to sprout as soon as snow melts, *i.e.*, about *Baisakh-Jeth* (Mid-April to mid-June) in the hills and the uplands depending on elevation and aspect. In the lower elevations and on sunnier slopes, germination begins in the first week of *Baisakh* but on higher elevations and on northerly slopes, particularly when there has been heavy fall of snow, germination begins late in *Har* continuing right up to the break of rains. What is required for germination, to begin with, is sufficient heat in the soil, as moisture is always available in these elevations. Seed sown in spring germinates at least two weeks later than that sown in autumn. In about a week from the date of germination, about an inch of rootlet develops with two tiny cotyledons which are thick and pale green. When the plant is about a month old, then the first embryonic leaf is developed from the plumule, which is then surrounded by two obovate cotyledons one on each side. The leaf at this stage is covered with dense tomentum on either side, and is at first very much crumpled. Another leaf develops when the plant is about three months old, and at the end of the growing season, *i.e.*, in October, when the plant is 6 months old, it is about 6″ high, equipped with three leaves (the cotyledons having fallen) the middle, leaf being prominent and about 5″ across. The root is also about 6″ long. Germination takes place earlier in exposed situations as may be expected, but the subsequent growth of the plant depends much on the depth of the soil and freedom from weed competition. Where weed growth is heavy, the plant may be only 3″ high or even less at the end of the growing season.

The *kuth* plant generally flowers in the fifth year, but much depends on soil situation and aspect. The deeper and the richer the soil, the more rapid the growth of the *kuth* plant. Thus, for instance,

*Part I appeared in the *Indian Forester* for February 1935.

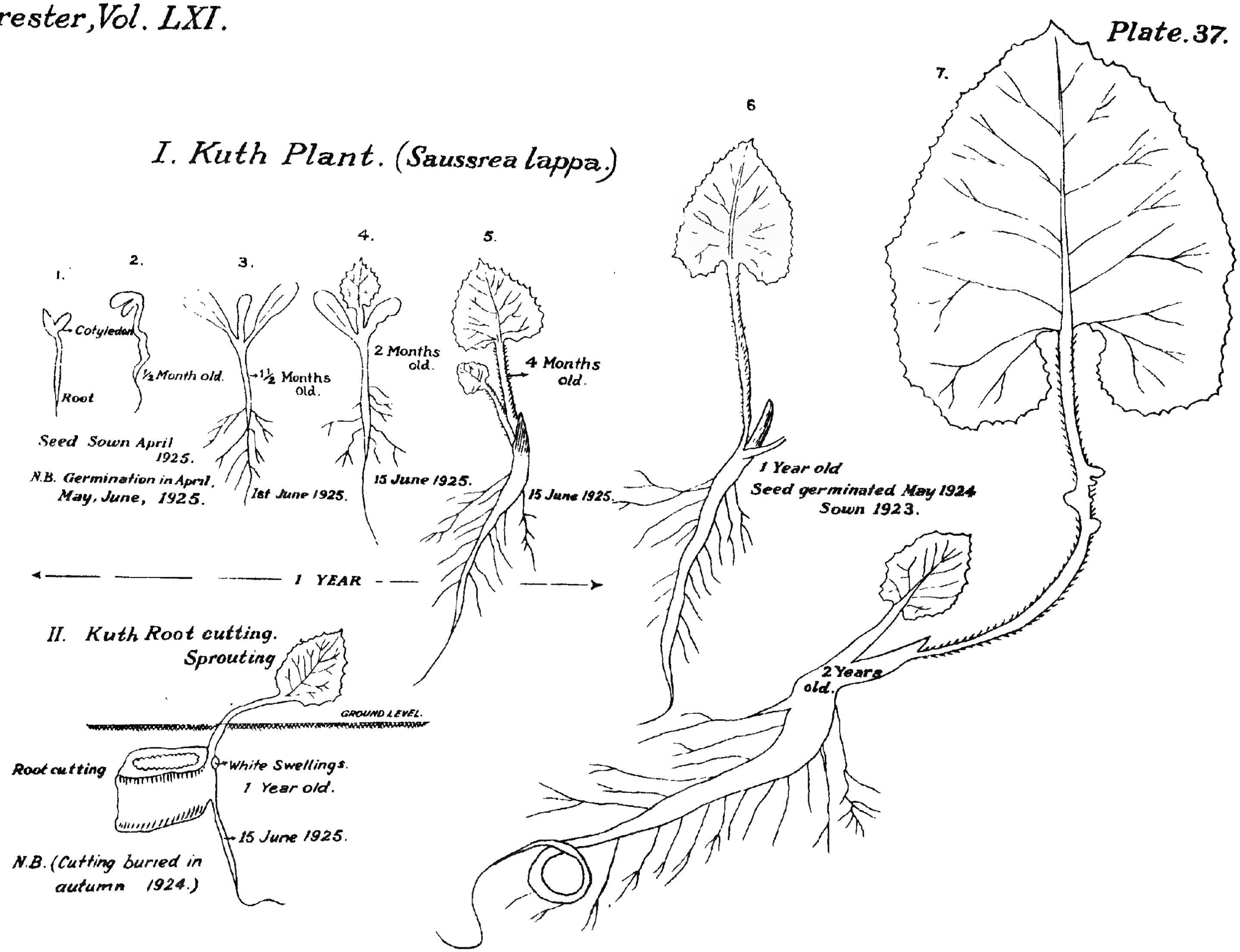
some nursery plants in Sinthan and Singpore nurseries where the soil was about a yard deep and black with rich decayed humus flowered in the very second year, *i.e.*, in about 16 months from the date of germination of the seed, the remaining plants all flowering in the third year. But this is rather exceptional rate of growth and cannot be expected in the forest where not only the soil is comparatively shallow, but there is much overhead cover which retards rate of flowering and of growth. Other things being equal, the more the light, the earlier the flowering, hence its early flowering on sunny slopes, southerly or westerly aspects as also under open canopy. It has been observed too that weeding has great effect on flowering, the lesser the competition from weed growth the earlier the flowering. This is, no doubt, due to the fact that the weeded *kuth* is thus provided with both light and food which it wants for its growth and flowering.

Kuth plants springing from root-cuttings also take the same time in flowering as seed plants and are governed by much the same conditions. But it is often observed that some collar plants either flower in the very first year of planting or in the following year. In such cases, the seed produced is often abortive and is useless for purposes of reproduction. These premature cases of collar flowering are to be ascribed not to exceptional rate of growth of the plant but to "organicity" of the *kuth* root, from which term is meant that the *kuth* root cuttings 'remember' as it were, their age, and therefore, flower, even after cutting, at the same age at which they would have normally flowered, *i.e.*, had the root not been cut and collars re-planted. As the collar portion is the thickest and oldest portion of the root, hence this portion of the root is first to sprout and flower when the reproduction is obtained from root-cuttings.

The marked effect of fertilisers on the growth of *kuth* plant is evident from the fact that disused *behaks* (camping grounds) of *Gujars* which are full of cow-dung, goat-dropping, etc., are excellent sites for culture of *kuth*, both Sinthan and Singpore being old abandoned *behaks*.

On the whole, it may be stated that the *kuth* plant flowers in 4-5th year in good localities, and in 5-7th year in poor localities or under

I. Kuth Plant. (Saussrea lappa.)



dark over head cover. For purposes of rotation, age of six years appears to be suitable for average sites both for exploitation and regeneration.

2. *Collection of Seed.*

The flowering begins in the first week of *Har* (mid-June) and continues to the end of *Bhadon*, but in cooler localities, flowering is deferred till *Sawan* continuing up to *Assuj* (mid-September). The heads are at first green, but soon turn dark or bluish green, when they are very conspicuous from a distance. The seed usually ripens in September, or a little earlier in warmer localities. It should be collected a little before it is ripe, or else it is scattered by the pappus growth. The heads should be cut with the stem about 2 feet long, and stacked in the sun, where they ripen in about a week and can then be threshed and winnowed. The seed is at first white, then becomes red-mottled, turning ultimately brownish-black. Each plant has, on the average, 5 heads of flowers, and each mature head has about 50—60 ripe seeds. Thus, there are about 250 seeds to each good mature plant. Seeds near the periphery of the involucral head are small and abortive and should be rejected. There are about 33,000 *kuth* seeds to a seer, which number is about four times the number of deodar seeds. The seed is dried for a week in the sun, and is then kept in corked bottles or in carefully closed dry gunny bags. The good seed is dark-brown in colour, full-bodied (at least 3″ long), and sinks in water ; the seed that floats in water is very often useless. If the seed is kept dry, it retains its vitality for a year or even more, but it is better to collect and sow fresh seed each year. The germination percentage is very high being anything up to 80 to 90 and even more.

Ripe seed that is not collected is scattered by pappus. The flower heads are eaten by deer, monkeys, bears and birds, and even black ants and buprestid beetles are fond to attack the raw fruit. After germination, cut-worms attack delicate seedlings, but if the nursery soil is clean and not very wet, then the damage is not appreciable.

3. *Methods of Reproduction.*

Kuth is easily propagated either by seed or by root-cuttings. The latter feature is very characteristic of *kuth* and is very useful

for insuring the production of *kuth* in exploited areas. The former method is cheap and effective, and may be further divided into two :—*i.e.*, direct sowing and transplanting. We will discuss the merits of these methods separately at first and then take them together in review, for it has been found that on different sites different methods succeed, so that there is no hard and fast generalisation as to what is the best method which may cover all areas.

(*i*). *Reproduction from root-cuttings.*—We will first begin with root-cuttings as ten years back this was the most popular method of securing *kuth* reproduction. It was observed that if root-cuttings 1″ to 1½″ long were planted in suitable soil at the time of harvesting the crop, then they develop new *kuth* plants. For this purpose, the cuttings are planted in 1′ deep pits and covered with about 1½″ layer of earth. If the soil contains the necessary amount of moisture, the cutting produces a shoot within 10—30 days depending on locality, aspect, and prevailing heat. Cuttings can be planted either in autumn, *i.e.*, before snowfall, or in spring from *Baisakh* to the end of rainy season, *i.e.*, *Bhadon*. Cuttings planted in autumn sprout as soon as snow melts from the ground, and if snowfall is delayed then they may sprout in the very year of planting, *i.e.*, late in autumn although their growth is then arrested. In the spring, the young shoots develop rapidly.

It is found that practically every root-cutting does develop one or more shoots, but whether these will survive depends on many factors discussed hereafter. The cuttings do not require watering and can be planted even in dry seasons when transplants will die from desiccation. The reason is that there is sufficient food material for the plant in the root-cutting itself, so that the plant does not make any considerable demand on the soil in which it is planted. It is observed that a number of white swellings develop on the periphery of the cutting, and each such swelling sends forth a plumule developing into a green leaf within about a month. If the plant is examined at this stage, it will be seen that while the shoot is exceptionally well developed, the root is either not developed at all or is only a tiny filament. In the first year, therefore, a root-cutting does not so much depend on its own root as

on the root-cutting which is drawn upon for food supply. It is only late in the season or even in the second year, that a root-cutting sends forth its own tap-root, and if that period happens to be dry, or if the soil is not suitable, then many root-cuttings die after sprouting. This explains why many *kuth* plantations raised from root-cuttings, which look so promising in the first year, fizzle out soon after. In many cases, the number of such plants shrinks to about 25 per cent. or even less in the second year. But those which do strike root in time continue to flourish and are established.

In the case of root-cuttings, it has been observed that the *initial percentage of success is maximum with collars, and then falls proportionately as the diameter of the kuth root decreases.* This is, no doubt, connected with available food-supply which is bound to be greater in the upper fleshy part of the root than in the attenuated ends. But this is not the only reason ; the dormant buds which sprout into shoots are found to be maximum in the upper part of *kuth* root and are least towards the apex, hence it is that the collar when planted produces not one shoot but sometimes even up to half a dozen shoots, each shoot springing from a different point from the periphery of the root-cutting, and then developing an independent rootlet. This will also explain why plants developed from collar cuttings have finger-shaped, branched root-systems which is in such a marked contrast to the carroty roots developed from seedlings or transplants.

Whatever may be true of collar plants, the fact remains that root-cutting plants do not prosper quite well in the long run, although to begin with the success may be even cent. per cent. The subsequent failure of the root-cutting plants is due to the fact that the production of the tap-root is delayed inordinately, *i.e.*, until the mother root-cutting is fully exhausted, which takes 2 to 6 months. One result of this is that at the time the supply from the cutting is exhausted, the plant is unbalanced (it has a well-developed shoot but tiny roots ill-equipped to support such a big shoot) so that the plant is likely to wither, particularly if the weather and the locality are dry, as is often the case. Only in favourable sites, *i.e.*, in wet depressions, do root-cuttings succeed, for here the water supply is never deficient. The second

reason why cuttings are now being discarded is that the operation is costly, as *kuth* root sells at about Rs. 150 to 200 per maund, and it is certainly a short-sighted procedure to let go the bird in the hand in the hope of catching two in the bush. Compared with root-cuttings, the second method of regeneration of *kuth* from seed is ever so much cheaper and, as we shall see, more effective. The only reason why root-cuttings came so much into vogue and into the limelight to begin with, was that the method appeared novel whereby one thought one could exchange old lamps for new ones!

But if this method of root-cuttings is at all resorted to, effort should be made to reduce the size of the root-cutting to the very minimum consistent with success. Experiments made in this direction show that root-cuttings about 1″ in diameter and 1″ long are quite sufficiently big for securing regeneration, and if bigger lengths are used, then not only is the *kuth* root wasted, but the production of the new tap-root is thereby inordinately delayed with subsequent harmful results. In the past, cuttings even up to 3″ long have been used, but this was certainly a mistake. It has been found further that even slices of *kuth* succeed well, the following gives the germination result of slices prepared from 1″ long roots:—

Percentage of success from planting slices of *kuth* root.

Slices 1″ long root cut in twain ..42 out of 60 =70 per cent.

Slices 1″ long root cut radially in 4..62 out of 125=51 per cent.

Slices 1″ long root cut radially in 8..44 out of 125=35 per cent.

Experiments have also been made with very small pieces of *kuth* root no bigger than a two anna piece, and although even such small pieces occasionally do succeed yet the *minimal effective length of a root-cutting may be put at ¾″ when the average diameter of the root is about* 1″. Roots bigger than this can be split into smaller, if necessary, radial pieces to produce the above effective dimensions. It should be remembered that only the periphery of the *kuth* root puts forth new shoots, hence while producing small pieces care should be taken that the whole of the periphery is not severed, as central pieces do not succeed.

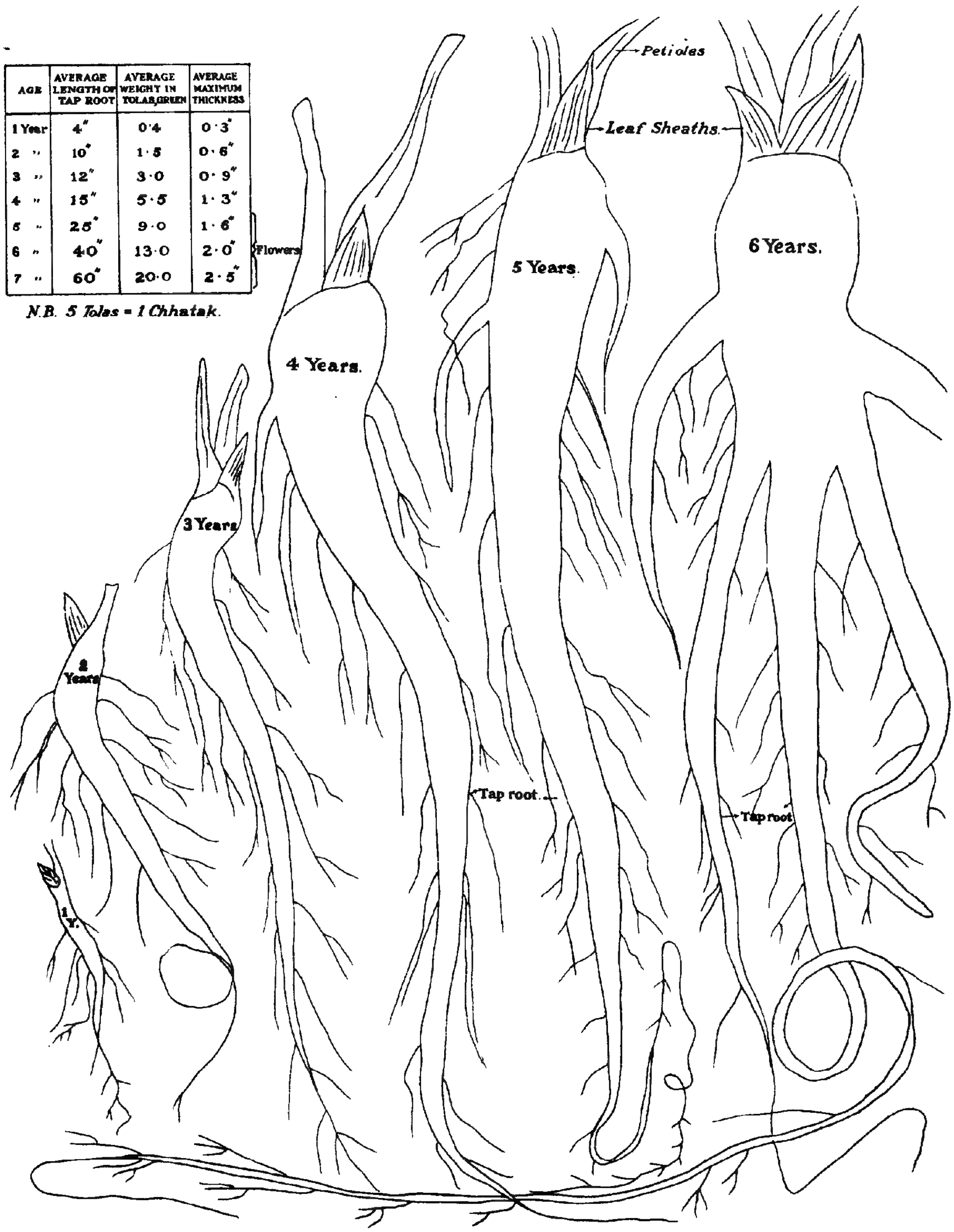
Last but not least, a very interesting fact has been observed in the

III. Kuth Roots of different ages in a good soil. (*Banihal Range*)

AGE	AVERAGE LENGTH OF TAP ROOT	AVERAGE WEIGHT IN TOLAS, GREEN	AVERAGE MAXIMUM THICKNESS
1 Year	4"	0·4	0·3"
2 "	10"	1·5	0·6"
3 "	12"	3·0	0·9"
4 "	15"	5·5	1·3"
5 "	25"	9·0	1·6"
6 "	40"	13·0	2·0"
7 "	60"	20·0	2·5"

Flowers

N.B. 5 Tolas = 1 Chhatak.



case of root-cuttings. Occasionally, it is observed that the shoot of *kuth* instead of coming from the upper portion of the cutting, as is usual, starts from the *lower* side of the cutting and then curves up, the root developing from the same point. This is due to the fact that at the time of planting the cutting the upper side of the root is inadvertently placed downwards. This is another instance of the "organicity" of the plant showing that we cannot deceive the *kuth* root by placing it upside down. Mistakes such as these should therefore be avoided at the time of plantation, for it is an unnecessary waste of time and energy to let the plant make a wrong start.

Another mistake made in planting root cuttings in the past was that they were put out even in *kail* or *kathi* (*Indigofera*) areas, although the elevation was sufficiently high. Even here root-cuttings did sprout at first and looked quite healthy, germinating within about a fortnight on account of sunnier slopes, but this spurt was deceptive as they succumbed soon after, falsifying the sanguine hopes of their success. This empahsises the need for care in selecting site, which is very important indeed, particularly in case of cuttings.

(*ii*) *Regeneration from Seed*.—This is obviously the natural and cheaper method, but it is only in the last few years that attention of the local foresters has been focused on it. The reason for this is not far to seek ; *kuth* grows on very high elevations, and although any quantity of *kuth* root can be got at any time of the year, yet the collection of seed in sufficiently large quantities is not always an easy task. Partly for this reason, and partly for the more spectacular preliminary growth of plants from root-cuttings, reproduction from seed did not at first receive the attention it deserved. When once the *kuth* plantations were established, a small but steadily growing quantity of seed was available, and hence this method of reproduction soon began to compete with the other method, for sowings made in suitable nurseries revealed that germination percentage of *kuth* is very high, indeed. But direct sowings in the forest did not give very promising results, as the seedling is so easily smothered by the surrounding weed-growth, or it succumbs to drought, hence it was soon evident that transplanting from the nursery stock is a much surer means of guaranteeing success

than sowing *kuth* direct. We will, therefore, first discuss transplanting and then consider direct sowing :—

(*i*) *Transplanting.*—The technique for transplanting is as follows: The seed is sown in *Katik* in a well-prepared nursery which is dug 4—5 times and is cleared of all roots, stones, etc., and is mixed with ash or animal manure. The nursery bed should be 1′ to 2′ deep and is generally at the foot of a hill, preferably on an open place so that it may receive direct overhead light which it needs at high elevations say over 8,500′. The seed germinates early in spring and is weeded thrice in *Jeth, Sawan* and *Bhadon*. At the end of the growing season, *i.e.*, in next *Katik*, many of the *kuth* plants are sufficiently big to be transplanted. At that time, they should be 6″ high and have only 3 leaves, their roots being about 6″ long. Plants of this size are quite suitable for transplanting and are put out in the forest in the first year, *i.e.*, 12 months after sowing. But some plants are smaller and develop shorter roots, say 3—5″ ; they are allowed to remain in the nursery and are not put out until they are 18 months old, *i.e.*, in *Sawan* or *Bhadon* next. Before putting out the transplants, the leaves must be nipped out, so that only the root portion is planted in pits about 1′ deep. This prevents transpiration and enables the roots to establish themselves ; failure to observe this precaution often ends in the death of the transplants.

Provided the plants of the right length, *i.e.*, about 6″ length of root, are available in the nursery, it is always better to transplant them out in the forest in the very first year in *Katik*, rather than let them remain in the nursery, as by so doing the plants have the whole winter to themselves to strike roothairs, and can then develop quickly in the new soil in spring. It is not advisable to transplant them in spring (except in Kashmir proper) as they are then liable to dry up in the following summer (*Jeth* and *Har*). Two-year old plants are best put out in rains, *i.e.*, *Sawan* and *Bhadon*,

i.e., when root-cuttings are usually planted. But provided the nursery site is favourable, it is always possible to put out the transplants in the very first year in autumn.

It has been observed that nurseries in the open give bigger and healthier transplants thanthose in the shade, hence advantage should be taken of this and nurseries prepared on N. W. or western slopes rather than on northern slopes which are sheltered from the sun. This initial start stands the plant in good stead in after-life, and may make all the difference to them in growth and establishment.

Transplants do well both in the open and in shelter of fir and birch trees, provided the plantation site is favourable and is not a sunny southern slope. They do not require any watering, but in the first two years light weeding is necessary to prevent their being smothered by weed growth which is a common feature of wet slopes. The cost of transplanting about 1,00,000 plants $4' \times 4'$ is from Rs. 60 to 100. The percentage of success being very high, Mr. H. L. Wright, then Chief Conservator of Forests, standardised this method for *kuth* propagation all over the State, instead of the old method of putting out root-cuttings. There is no doubt whatsoever that transplanting of *kuth* seedlings 12—18 months old is a great improvement on the old method of putting out root-cuttings which method besides being wasteful is so disappointing in the long run.

(*ii*) *Direct sowing.*—Although transplanting is a sure and certain method of success, yet it cannot be considered the easiest method. Transplanting process is troublesome and costly and in out of the way places where *kuth* grows, the supply of labour is by no means easy. Hence, a further step forward was taken at Sinthan, when direct sowing was tried side by side with forest nurseries scattered over the area near the planting site. Instead of digging deep pits, wherein the seed also was often buried deep by untrained labour, surface-scratches or shallow pits were made in a rough and

ready manner and sown with 2—3 seeds each. The results of direct sowing were promising being about 50 per cent. Further, inasmuch as the planting distance has been reduced to $1' \times 1'$, failures in germination do not much matter as thereby the espacement is automatically set right to what it should be, *i.e.*, say at 2′ to 3′ distance. It is as yet too early to pronounce as to the success of direct sowing on every site, but the results so far attained at Sinthan and Sathri Gali, Kuntwara, show unmistakably that we are on the right track, and even if the percentage of success be not so high elsewhere, yet this should not deter us from pursuing the path, as forest nurseries will always be available for transplanting, and all that is intended to do, is to take the first advantage of direct sowing, and then to complete the area by transplants. It appears that the method of the future will be direct sowing supplemented as may be required by transplants. This does not mean that we are departing from the standard technique, only the standard is being evolved and discovered. This much is certain that seed sowings and transplants will come into greater prominence in future, and therewith also closer spacing, for it is cheaper to sow *kuth* thick rather than weed it very often, which is necessary with wider spacing.

Concluding Remarks.—Finally, it may be stated that every method has its own use. For instance, although root-cuttings may not be much used in future, yet in natural *kuth* areas, pieces left in the ground at the time of *kuth* exploitation do continue to sprout and to supplement regeneration from seeds, and hence it is a standing *kuth* rule that no portion of the root less than half an inch in diameter will be removed, the object being that the portion left underground may grow up again. Similarly collars which have no commercial value, are, according to another standing rule, ordered to be cut off and planted with the stalk portion upward, as that is the most productive portion of the whole root. Root-cuttings will probably continue to be used, *i.e.*, until the seed-supply is available in sufficient quantity, and

they must certainly be tried in too wet places where even transplants fail. In all other places, it is best to sow seed as it is so cheap ; the viability of *kuth* seed being remarkably high Transplants give about cent. per cent. success and about 500 to 1,000 can be put out at the cost of a rupee. They do well both in light and shade, but would fail if the soil is very shallow and the aspect is sunny. They must not be put out in *Jeth* and *Har* for that is the driest portion of the year, nor should too delicate plants be planted out.

Direct sowing should be tried at the foot of the hills, particularly in open blanks, for here moisture is always available at elevations suitable for *kuth* and the direct overhead light enables *kuth* to germinate much earlier than when sown among competing weeds, but southern slopes should be scrupulously avoided. Seed sown under a dark canopy of fir will either not germinate at all or will germinate very late when it is likely to be smothered by weeds which spring up early. Whenever a suitable site is available advantage should be taken of direct sowings at first as it is cheaper than putting out transplants. Sowing in the nursery and in the forest is best done in autumn, and this should be done *before* the ground is frozen by frost as sowing done late in *Poh* very often fails for that reason. The best sowing and transplanting time is *Katik-Maghar*. In nurseries sowing may also be done early in spring, *i.e.*, if for any reason sowing could not be done in autumn, but autumn sowing gives the plant a start which it so much needs on cool slopes.

It will thus be seen that transplants are by far the best, but collars are just as good, and in places direct sowing is also successful.

4. *Statistics of yield and growth.*

The statistics of yield and growth are under compilation, and it must take considerable time before any standard set of figures may be arrived at. Moreover, it appears that as in the case of conifers, it will be necessary to classify site into a number of quality classes depending on depth and moisture. We find the differentiation into good, average and bad sites, in all forests. The following tentative figures may be considered to fall in between the first two quality classes. In this table, the age of the *kuth* plant is correlated with the

diameter of the *kuth* root at collar, its length and weight when green, and for purposes of comparison size of leaves which grow with age (although not regularly) is also given for rough ocular estimate in the field :—

Age.	Length of root.	TABLE GIVING DATA ABOUT *kuth*. Diameter at collar.	Weight of green *kuth* in *tolas*.	(AVERAGE GOOD PLANTS). Leaf-petiole.	Leaf-lamina.
6 months ..	4-5″	0·3″	½-1	4″	5″×5″
1 year ..	7″	0·6″	1-1¾	7″	8″×7″
2 years ..	10″	0·8″-1″	3-4	10″	11″×14″
3 years ..	13″	1¼″	10-12	20″	15″×18″
4 years ..	15″	1½-2″	15-20	24″	18″×18″
5 years ..	20-25″	2½″	30-35	26″	15″×20″
6 years ..	30-35″	2½″-3″	40-60	30″	18″×24″

(*N.B.*—Five *tolas* equal to one *chhatak*).

It will be seen that at the age of five when the plant is mature and in flower, the root is already about two feet long and a little less than half a seer when green. Some roots grow much larger and attain great weight, the greatest weight attained at Sinthan being 5½ seers green. There is no doubt that in its natural habitat *kuth* root may develop considerably heavier weights, but ordinarily the root begins to decay after it is about five, and it should not be kept longer in the field. The rot spreads from the collar downwards and the powdered mass produced becomes a hot bed in which millipedes breed. As a general rule, collar-plants produce bigger roots than transplants and this is due to the fact that instead of one big taproot characteristic of a transplant, the collar-plant sends forth a number of rootlets from the central lump producing a reversed candelabrum, but much also depends on spacing, for plants grown too close are bound to be cramped.

(*i*) *Dryage percentage.*—It will be seen that weights given above are those of green *kuth* root. Co-relation of green *kuth* root with dry *kuth* is, therefore, necessary. The following data which was compiled at Sinthan by Mr. S. D. Mengi, Forest Ranger, gives moisture percentage of *kuth* root for different months of the working season :—

Month of extraction.	Green weight.	Dry weight.	Dryage.	Loss per cent.	Remarks.
	Tolas.				
1st week Har ..	280	63	217	77	
3rd Ditto ..	111	28	83	74	
1st week Sawan ..	112	24	88	78	
3rd Ditto ..	167	48	119	71	
1st week Bhadon ..	83	26	57	70	
3rd Ditto ..	93	27	66	71	
1st week Assuj ..	320	95	225	70	
3rd Ditto ..	190	62	128	67	
1st week Katik ..	5 *vatis* & 121	2 *vatis* & 11	500	64	Minimum moisture.
3rd Ditto ..	1 *vati* & 20	62	118	65	Ditto.
1st week Maghar ..	320	96	224	70	

(*Vati*=2 seers).

It will be seen that minimum moisture is in *Katik* (Oct.-Nov.), but as at that time extraction becomes difficult on account of cold, hence *kuth* is extracted sometime in *Bhadon* in the hilly areas. Moisture percentage will also depend on locality, *i.e.*, whether it is shallow or deep, wet or dry, as also on the age of plants, but generally we will be erring on the right side if, as a rough rule, we

consider the *dry weight to be one-fourth of green weight of kuth root.*

(*ii*) *Area and yield.*—Lastly, an idea might be given of yield of *kuth* from a well-stocked *kuth* area such as is found roundabout the forest rest house, Sinthan, which as already stated is an exceptionally good site. About 1,500 sq. yards of this area, equivalent roughly to 1/3rd acre yielded 9 maunds of dry *kuth*, which is equivalent to say 25 maunds per acre of dry *kuth* for a first quality soil. Soil of second quality will yield at least 10 maunds dry *kuth* per acre, with an espacement of 2′ by 2′.

Considering that *kuth* sells at Rs. 150 per maund, and that it can be produced within 5-6 years at a very nominal cost, this means a return of $\frac{150 \times 10}{6} = 250$ or say Rs. 250 per acre of productive area of average quality, *i.e.*, under conditions which are obtainable in a good plantation. But the figures given above do not apply to the forest where the plants are not so dense nor so evenly mature. Hence, it would be safe to reduce the Sinthan figures, where the spacement was less than 2′ by 2′ and all plants mature, by the multiplying factor 1/10 to get the conditions obtainable in the forest. Actual experiments made in the field show that a first class site yields about 2 maunds dry *kuth* per acre, second class site about 1 maund per acre, third class site yielding half to a quarter maund only. Even so, the returns from *kuth* are much higher than those from conifers, acre for acre. But it is most essential to choose a correct site for a plantation, as otherwise failure would be the inevitable result.

5. *Age of the kuth root.*

Although the age of a plantation is very often known from the records maintained for the purpose, yet it is very useful to be able to check the age of the *kuth* root by direct observations made on the root itself. The following method has been evolved after many observations on a large number of roots, and it takes into consideration rings in *kuth* root such as are produced in conifers each year. If we cut a section of the *kuth* root, it is possible to see a number of rings,

and if all of these rings could be counted, then the age of plant could be found out. The complication arises in the fact that the rings become very indistinct towards the pith, and it is only in the middle portion that they are distinct.

To get over the above difficulty advantage is taken of yellow gland-dots which also form conspicuous rings—rings which are much more easily discernible than rings of woody tissue. But even here a little difficulty arises, as the outermost tissue is full of glandular dots, instead of forming one distinct ring. The method resolves itself into differentiating the following portions in a *kuth* root section :—

(*i*) The central pith.

(*ii*) The middle portion which contains medullary rays and has distinct glandular rings, one such ring being in each annular woody ring.

(*iii*) The outermost woody ring which is full of yellow gland-dots, but has no distinct glandular ring. This portion can be easily peeled off, like an onion scale.

The correct method of finding the age of *kuth* root is to cut a transverse section of the root a little below the collar, *i.e.*, where ringed tissue is apparent, and then count the age from outside inwards: portion (*iii*) corresponds to sapwood and corresponds to one year, the inner rings can be counted distinctly for one or two years, but where *they are indistinct, count glandular rings instead* which are yellow or brownish, omit the central ring of the pith which is common to plants of all ages. The result is the age of the plant which may be stated thus mathematically :—

Outermost ring (1 yr.) + woody rings or alternatively glandular rings in the middle portion, *minus* the pith ring = age in years.

It is necessary to cut section near the collar as the apical portion of the root is not representative, being the youngermost.

6. *Is it a root or a rhizome ?*

Finally, the interesting question may be asked as to whether *kuth* root is really a root or a rhizome. The fact that it produces dormant buds which can easily regenerate, the plant tends to show that it may be rhizome. But rhizomes generally creep horizontally below the

surface of the earth, producing root and shoot from apical portions each year. But the *kuth* root is distinctly carroty, spreading downwards, and its histological character also shows that it is really a root. It would appear, therefore, that the *kuth* root has evolved a new feature of its own during the course of its evolution, whereby it has become a combination of a root and rhizome. The collar portion would appear to be a distinct rhizome, as once the plant begins to flower, it continues to do so for years afterwards producing each year a new peduncle on the peripheral portion, the older peduncle dying at the end of growing season, the growth of the upper portion of *kuth* root thus becoming centrifugal. But the lower portion of the root spreads downwards, and its dormant buds come into play only if the upper part is cut or disturbed. Production of sprouting buds (gummules) by roots is therefore a special feature of the *kuth* root.

FERTILITY OF SEED FROM TAPPED CHIL TREES.

By H. S. Jamwall,
Conservator of Forests, Jammu.

Last year during his tour in the Udhampur Division the writer had an opportunity of inspecting some of the *Chil* (*Pinus longifolia*) Forests of this Division where resin tapping operations had been going on for the last two decades.

Though the writer was very much impressed to see the resin work so economically being carried out by the Divisional Forest Officer, yet it pained him much to observe the unhappy and sickly condition of these forests.

In places the crop is virtually deteriorating from excessive tapping which is obvious from more than a dozen old channels on the bole of a single tree some of which are not less than 4″ to 5″ in depth.

The deleterious effect of heavy tapping in the past and the continuity of the operations, though lighter now, is so evident that one cannot help thinking seriously for the future of these forests,

Kuth Nursery at Singhpur. *Photo by H. L. Wright.*

Fertility of tapped *chir* seed. *Photo by S. D. Meengi.*

The outstanding features of these forests, as found by the writer on close observation, are as under:—

1. Complete absence of regeneration under the old stand.
2. The general unhappy and sickly appearance of trees that had incessantly been under tapping operation for the last two decades.

As regards No. 1, the writer inquired from the Divisional Forest Officer and the Forest Ranger in charge Udhampur Range of the adverse factors that were responsible for the total absence of regeneration in this area. The Forest Ranger in charge stated that the principal reason for absence of regeneration was the defective quality of seed that was available from tapped *chil* trees. He stated that most of the seed obtained from tapped trees was infertile, hence there was no sign of regeneration in these forests.

He further stated that he tried to sow some of the blanks with this seed but failed to obtain any regeneration due to infertility of seed. He maintained that whatever small percentage of the fertile seed from tapped trees germinated the seedlings remained weaklings and could not withstand the rigours of the summer drought and they died before the hot weather was over.

Though the Divisional Forest Officer (L. Kewal Kishen Nanda) did not fully endorse the above theory of the Forest Ranger, yet he too could not account for the factors inhibiting the progress of regeneration in these forests.

The writer refused to accept the explanation of the Forest Ranger and in order to give the lie to his views, asked the Divisional Forest Officer to supply him with a seer or two of the *chil* seed collected from these trees so that he would sow the same under his own personal supervision and demonstrate it to the staff that absence of regeneration in these forests is due to other adverse factors of site and not to infertility of the seed.

The Divisional Forest Officer supplied about one seer of *chil* seed which was sown under the writer's own supervision in the compound of the Sangyal Forest Rest House. Though the freshly broken land was unsuitable for the purpose, as it could not be pulverised and

weeded out as thoroughly as the writer wanted it, yet it was prepared as carefully as was possible within a short space of time. The new soil was broken and prepared in the presence of the Divisional Forest Officer and the Forest Ranger, and the seed was sown broadcast in three beds when all of us were present.

From the reports received it was found that germination was simply marvellous and that the seedlings had not only remarkably withstood the rigour of summer drought but were in excellent condition. The average height was about 9″ in eight months, *vide* Plate 39, Fig. No. 2.

It is indeed a pleasure to see the same Ranger reporting the excellent germination of seed and the good condition of seedlings sprung therefrom.

This small nursery of *Pinus longifolia* seedlings consisting of three beds only is virtually the first of its kind in this Circle and it is a model one to demonstrate to all concerned that there is no difference whatsoever in the quality of the seed obtained from the tapped or untapped trees and that germination is equally good in both cases provided the officer in charge of the work knows his job well.

As regards the deleterious effect of injuries caused by incessant tapping the only remedial measure to be adopted is to give them rest for a period of 10 to 15 years during which time most of the wounds are likely to heal up.

[We would recommend the author to study the resin tapping rules of the United Provinces and the Punjab.—ED.]

A PYTHON IS CAPTURED.

BY KAMAL.

In December last, while passing through an old clearing in the evergreen forests of a reserve in the Naga Hills, which was evidently an old camp site of sawyers, the writer drew attention of the Garo Gaonbura,[1] named Mymensingh, in memory of his being born while his father was out with his battalion in that district, to a python which was disappearing in the shrubs within a foot of the man's foot.

[1] Village head man.

Evidently it had been warming itself in the sun. The man cast a hurried look at it and the distance was more than one foot in no time.

The writer, having seen a pair of them being captured by some Munda ex-Tea garden coolies, and having kept them below the *chang*[1] of his camp-hut for more than a month, was not afraid, and wanted to capture this one alive himself and was helped to a considerable extent in this by an old tracker who was with him when these pythons were caught. Two strong sticks with forked ends of suitable size were obtained by cutting the ends of forked saplings slantingly to give them sharp ends. On peering into the bushes in which the python had disappeared it was seen to be making for some denser shrubs on the other side. It was stopped by sending two men on two sides to cut the jungle in between. Then the snake coiled itself and sat there awaiting events, in the best posture it could command. The jungle was cautiously cut till it could be clearly seen, and then its head and body were pinned down hard in two places, between the forks. The rest was easy, though not pleasant. A coolie brought a long cane from the forest, one end of which was softened by twisting it, and slipped behind the head of the python, and a running knot tied on it as tightly as possible. Then two men were sent to pull at the other end of the cane and the forked sticks were released.

The snake arched its head, not knowing that this made the slipping of the cane rope doubly impossible. It twisted its tail round some saplings. These were cut, and the snake dragged out on to a cleared path, from where it was brought to the car. A sack was procured and thrown over the head of the python, when it had slowly crawled in, the mouth was tied by a string and the snake was brought to the camp in the car. It was decided to send it to some Zoo. A large empty barrel was secured, and the sack emptied into it. The snake darted its head out but being too heavy was unable to crawl out. The rope was pulled to one side and the python's head again secured with a forked stick, the cane noose was opened and a secure lid put on the barrel, and heavily weighted.

Next morning, word having gone through that an "Ajagar" had been caught, hundreds of villagers came to see it, and opening

[1] Wooden or bamboo platform.

a small chink between the barrel and its lid, and standing as far behind as possible, looked at it admiring its size. Then a Sema Naga came, salaaming, his face wreathed in smiles. The smile had a meaning, if he skinned the python would he be given the meat? The offer was regretfully declined. Could he then at least see the snake? The permission was given. "Aithu" he shouted to some of his brethren passing nearby and they came in haste, their faces also wreathed in smiles, which however disappeared after a couple of minutes talk. But they went to the barrel, and took down the lid. The snake glowered at them with its head ready to strike. A hand was cautiously held over the barrel, and the snake, as it darted, caught behind the head, pulled out, and held like a thick and heavy rope by three men. The flesh was felt, and beseeching glances cast again, but no change of mind being seen, the snake was put back sorrowfully in the barrel, and the lid closed on it again. Could at least one favour be granted. Could they go to the place where the python was caught to capture other pythons who were sure to be there? This also could not be granted. It was a reserved forest. Permission given once to catch pythons would result in shooting of deer and pigs later on.

Some days after, the snake was sent to the Calcutta Zoo in a large box in charge of a gentleman going there. It was a female python and measured about 12 feet.

PLANTING OF VILLAGE COMMON LANDS.

By F. L. Brayne, I.C.S., Commissioner,
Rural Reconstruction, Punjab.

The editorial of the June number of the "*Indian Forester*" discusses village forests and suggests that village uplift societies should induce villagers to plant up their common land. It sounds easy enough but a few paragraphs on we read the ominous admission that "Common property is nobody's property." "Ay, there's the Rub!"

There are three ways of planting up common lands. The first and easiest is to divide them up and teach each owner to plant his own share. In the Jhelum District Salt Range of the Punjab there

are one or two villages which have managed to maintain good forests on their common lands, but these villages are peculiar. They are hidden away where timber has no market value and they consist of a vast area of hill with very few owners, but among them one or two enlightened and influential leaders. Elsewhere, common lands are generally as bare as the desert. Where, however, the common lands have been divided, the individual owners, even without special teaching, have often put up dry-stone walls, warned off graziers and, after terracing what they can for cultivation, have made reserves of the rest and in a few years the bare rocks have sunk out of sight, a thick mat of grass and young shrubs and trees has appeared, and erosion has been altogether stopped. One often comes across these small and highly successful private reserves, when touring in the hills, and in one village the whole of the common lands have been so treated and form a remarkable demonstration of the possibilities of successful re-afforestation.

The second way to afforest common lands is to hand them to Government and let Government do it. This has been tried in the Gurgaon hills, south-west of Delhi, and is a great success. The owners were persuaded to hand over a portion of their *shamilat* to Government ; Government appointed staff and spent a little money on bunds, seed, etc., and first class results have been achieved. Without the good will of the villagers no closure can be effective and this has been secured by an annual remission of land revenue, some of which is spent on watchmen appointed by the villagers themselves to ensure that there is no trespassing. The forest belongs to the people, and they can cut grass and take away dead wood, but they neither graze, cut, lop nor burn.

This excellent method unfortunately costs money and at first, at any rate, it takes a very great deal of persuasion to get villagers to hand over their *shamilat*. The villager is full of suspicion of the motives of the benign Government and is certain that once he hands over his hill-side, he will never see it again ! Time and experience, however, breed confidence and, if money were available, this would be the very best way of afforesting common lands.

The third way, and the most difficult, is by joint village action. The old panchayats have died out and the new panchayats have not yet made good and, until a panchayat has made good, I doubt if it can touch the administration of common land. It is all that a panchayat can do to decide petty civil and criminal cases and that is supposed to be the very easiest of their functions. As for cleaning and keeping clean the village streets and lanes or repairing the village roads or generally assisting to make the village healthy and comfortable, this is at present beyond nine out of ten panchayats in the Punjab. How can they touch such a thorny problem as the common land! Panchayat management of forests may come in time but a lot of training in self-government will be necessary before either *panches* will create and administer village forests or the villagers will allow them to try. The individual villager is a hard-headed sensible fellow and not hard to teach how to protect his own individual interests. It is when communal action is required and one hundred per cent. of the village has not only to be taught but also persuaded to act and to act as one man, that difficulties arise. Each individual who can be taught to look after his share of the hill-side becomes a demonstration and the idea soon spreads, but nothing can be done with the village as a whole until unanimity has been secured and the more one tries to persuade the deeper becomes the suspicion that there is something more in it than mere tree planting!

Many of the sheep and goats that ruin the hill-sides belong to menials, butchers and other non-owners, but such is the charity and easy-going nature of the villager that he is very loath to exclude them from the common lands. Even wandering *Odes* and other nomads are allowed to graze free and a campaign against all these non-owning graziers would rouse a vast public in their defence.

The first line of attack is propaganda and the teaching, by every possible means, of every class of the public. The hillmen must be taught that they could get three times the income they do now if only they would administer their hills scientifically, but even more important is it to teach the plainsmen that it is the stupidity, carelessness and selfishness of the hillmen which is reducing their

cold weather supply of canal water, lowering the water-table of their wells, causing gigantic floods, burying their soil under sand and cutting away their villages and fields. When the plainsman is really roused to the iniquities of the hillmen, then action will be easy, but at present if we threaten to lay hands on the hills, there is a pious outcry from the plainsmen that we are taking the bread out of the mouths of poor and worthy graziers! These things must be taught in schools, in the public press, by cinema, by wireless and by every means of publicity known to man, until the great general public, whether hill-dwellers, town-dwellers or village-dwellers, understands exactly the why and the wherefore of hills and forests, of rainfall and erosion and of floods and drought.

VITEX PEDUNCULARIS AND BLACK-WATER FEVER

By L. J. de la Nougerede.

Plants are as we know the great chemists in Nature. They obtain simple substances from the earth and from the atmosphere, which with the aid of chlorophyll (the green colouring matter in plants), they convert and build up into the most complex compounds, producing the different forms and textures of plants, as well as imparting to them different tastes, smells, colours, etc., which constitute the hereditary distinguishing characteristics, by which the individual can be recognized.

The roots of plants also possess enzimes (toxins), capable of destroying very hard substances, and with these and the pressure exerted by the growing roots, they can disintegrate even rocks, and thereby provide foothold for the plants.

Primitive people are entirely dependent on the resources of Nature for all their requirements, and it is therefore not at all surprising that they learnt to utilize plants for producing poisons to fight more powerful enemies as well as for killing game and fish, for manufacturing crude medicines to combat various ailments, for fashioning armaments, ornaments, and even preparing their colour schemes.

In the dim and distant past some of our ancestors acquired knowledge of the efficacy of certain shrubs and herbs in the treatment

of certain diseases. This secret knowledge was most zealously guarded, and the cures effected were often regarded as miraculous, and it may reasonably be inferred that at a time when diseases were hardly understood and diagnosis almost unknown, the use of these infusions and decoctions occasionally had unhappy results. It is no doubt due to these unfortunate results, that these, our first doctors of medicine, then called witches, were often put to death on account of their uncanny knowledge known as witch-craft.

Out of this humble and much derided origin has sprung our present comprehensive knowledge of medicine, and with the advance of knowledge and growth of civilization we have now classified the bulk of our plants, and determined to a great extent their properties in relation to man's requirements and, what is more, prepared comprehensive treatises, recording these systematically for easy reference, in works as Watt's Encyclopædia of Economic Products, Materia Medica, the British Pharmacopœia, and various other voluminous medical and scientific books.

However, our field of knowledge is by no means exhausted. Changes in environment produce transmutation and evolution of species, and new factors are constantly being evolved. This is true in the case not only of plants but also of animals, including man, so that "Do at Rome, as the Romans do," is no idle saying. The process of evolution is so very gradual that it is hardly perceptible in the case of individuals with a comparatively long life-cycle, but fairly obvious in the case of individuals with a very short one.

The above goes to show that the knowledge we have gained so far may be compared with the knowledge of a student just leaving College. His brain has been trained or moulded into a receptive or perceptive condition, ready to assimilate real knowledge yet to be gleaned from that best of all teachers,—Professor Nature.

It is thus we find primitive savage tribes using certain plants and animals to obtain astounding cures and manufacturing dyes that will leave a permanent stain on a hard non-absorbent surface like the common cane (*Calamus tenuis*).

The Kols, Sonthals, Oraons, and Mundas use the leaves of *Vitex peduncularis* as a febrifuge, and it is from them that we have learnt to use it for Black-water.

It was somewhere in the winter of 1918 or 1919, that Mr. A. W. Blunt, Conservator of Forests, Assam, visited the Cachar Division of which I had charge at the time, when he related to me one evening in the Forest Rest House at Loharbund, how a friend of his in camp with him in the Central Provinces was cured of a chronic attack of Black-water fever by a Civil Surgeon who obtained some *Vitex peduncularis* leaves from a Roman Catholic Priest in charge of a Sonthal Mission. The Civil Surgeon had implicit faith in the use of these leaves in cases ot Black-water, and Mr. Blunt told me that if ever he got Black-water, he would certainly use *Vitex peduncularis.*

Many years later I remember reading a circular letter of instruction on the use of *Vitex peduncularis* by Lieutenant-Colonel Horne, Inspector-General of Civil Hospitals, Central Provinces, which shows that this eminent Medical Officer held a very decided opinion on the efficacy of *Vitex peduncularis* in the treatment of Black-water cases.

The writer of this article, a Forest Officer of Assam, has spent a large number of years in some of the most unhealthy forests of Eastern Bengal and Assam, even when the Province was not what it is to-day, but it was then reckoned the white man's grave. During these years he has known of so many deaths of Tea Planters and Forest Officers in Assam and the Duars from Black-water that his own and his brother's experience of Black-water is now recorded in the hope that it may be the means of saving the lives of others attacked by this fell disease.

Black-water, as its name implies, is due to the destruction of the red corpuscles of the blood which pass out with the urine, and give it its black colour. In the initial stage it is a reddish or pinky tinge, growing darker as the disease develops. Its cause, I think I am right in saying, is yet unknown.

In the beginning of 1926 my brother "A" came to Nowgong to spend a short time with me, and looked decidedly very ill on his arrival. He went to bed with fever the same day, and a couple days

later by chance I discovered that he had Black-water in an advanced stage. I called in the Civil Surgeon who brought the Assistant Surgeon and the Sub-Assistant Surgeon named Monoranjan Sen-Gupta (a most careful and painstaking officer).

The Civil Surgeon pronounced the case very serious and on his advice I called in a Planter Doctor with very extensive experience in Malaria and Black-water cases, and one who had made a name even among the medical faculty. They took the blood calculus, and found hardly ten per cent. of the red blood corpuscles left, and after some consultation among themselves, informed me that "A" would not survive till next morning. I asked if I might try *Vitex peduncularis*, and was informed politely, but nonetheless sarcastically, that I might try anything I liked, as nothing could make the least bit of difference. It was then 3 p.m., and only my intimate knowledge of the forests of my Division and the trees therein was the means of saving my brother. I immediately bethought of a large *Vitex* tree alongside the Dabaka road, and dashed off in the car at breakneck speed to get a supply of the leaves. Having obtained a sufficient quantity, and with the help of Monoranjan Sen-Gupta and Babu J. N. Chatterji, my Head Clerk, we prepared a decoction in the proportion of 20 ounces of water to every ounce by weight of leaves. The patient was in the meantime given the juice of "bedanna," a species of pomegranate, to keep up his strength, and barley water to stimulate the kidneys and to prevent retention of urine which usually causes death by the poisoning of the system.

Incredible as it may seem, after giving one ounce of the decoction every hour, in three or four hours all signs of the Black-water disappeared, and the urine resumed its normal colour, and the patient whose coffin had been prepared under the doctor's instruction, is alive and well to this day, while poor Mr. Abbott who had the coffin made is dead many years.

A few days later some Mymensinghias from Hybragaon (a portion of Nowgong town separated from the rest by the Kullung river), came to Babu J. N. Chatterji and asked for some "Jadu" leaves,

with which they heard the Sahib had cured his brother of Black-water, as a near relative of theirs was stricken with the disease and was at the point of death, while one or two others in neighbouring villages had died of the same complaint a short time before.

These same men returned a few days later, very grateful and wanting to pay for the leaves which had cured their relative. They were very thankful and surprised that the leaves were given free of charge.

The magic-like cures in Nowgong made quite a local sensation at the time, and I did not know till my return to Nowgong five years later that the plant had been grown in the Nowgong hospital compound, and that this was the means of saving my life from this fatal disease when attacked just prior to my being relieved of the charge of the District, a second time. It was towards the end of May—I was waiting to be relieved, and with my wife and infant son was touring in the Nowgong District, afflicted with the recent loss of our darling daughter, and growing desperate waiting for my relief, which for some reason or other was not available, till my wife as well as myself got laid up with fever. It was at this moment that I got attacked by this horrid disease, with my wife ill, and a wee infant on our hands. I recognized the symptoms which developed.

The urine was now black as ink, and I sent for my Head Clerk Babu J. N. Chatterji, who had assisted me when my brother was ill with Black-water, and when he saw the urine he got very alarmed. I asked him to say nothing for fear of alarming my wife, but gave him some money and asked him to wire the Range Officer, Jamnamukh, to send me some *Vitex* leaves immediately. Imagine my relief when he told me that they had planted the tree in the hospital compound, from which he would get me some leaves.

He very kindly prepared the decoction and brought it to me. I started treating myself with this and continued the treatment even after my arrival in Shillong. I also brought a quantity of the leaves with me, but I am glad to say that these were not required.

Preparation :—Green leaves are made into a decoction in the proportion of 20 ozs. of water to every ounce (by weight) of leaves.

All loss by evaporation is made up by adding boiling water. An infusion of the dried leaves is made in 40 ozs. of water to every ounce (by weight) of leaves, and loss in boiling is made up by adding boiling water.

Now a few words for the tree itself. *Vitex peduncularis* is a tree 20 to 40 feet high with a full crown of which the branches, branchlets and leaves are very evenly distributed. The bark of the tree is grey and smooth, save for evenly distributed very fine longitudinal shallow lines of fissures.

The leaves are digitately trifoliolate with the slender petioles 2″ to 4″ long slightly winged, as are also the petiolules which are only one-sixth to one-third inch long. The leaflets are acuminate $4\frac{1}{2}$ inches long by 1 inch broad, glabrous bright green when mature, slightly pubescent when young.

The fruit is a globose drupe a little less than a quarter of an inch in diameter, borne in lax panicles or straggly elongated bunches, broad at the base and tapering to the apex.

As far as is known it would appear to be *Vitex peduncularis* (Wall.), variety Roxburgiana which is so efficacious in the treatment of Black-water fever, but it may be quite possible that others of the species *Vitex* (of which there are a large number) may possess similar properties.

It is worth remarking that this plant is found usually in areas where this fell disease occurs, as is the remedy in the case of stinging nettles, etc., so that it would appear that Nature always provides a salve to her stings for those who study her ways.—(*Copyright.*)

INDIAN WOOD PRODUCTS COMPANY, LTD.

By S. Ramaswami.

Minor Forest Products Section, F. R. I., Dehra Dun.

It is mentioned in *Commerce*, June 29, 1935, page 958, that the Indian Wood Products Company, Limited, issued the following circular letter to its shareholders on the 15th June 1935:—

"Owing to a considerable accumulation of *katha* stocks in the principal consuming centres your directors decided temporarily to

keep the factory closed after the annual overhaul had been completed on May 6, 1935. A thorough survey of conditions in the various markets has since been conducted and your directors feel that, until the existing stocks have been very materially reduced, it will be in the best interests of the company to refrain from producing further quantities of *katha* and cutch. The situation calls for no undue anxiety, as the company is fully secured against all outstandings, but naturally the period of inactivity will be reflected in the earnings of the company for the current year. It is impossible at this stage to state when production will be resumed, but it is the opinion of your directors that it will be inadvisable to restart the factory until stocks in the consuming centres have been reduced to normal dimensions."

As we have received several enquiries from persons or firms desirous of starting *katha* manufacture on a factory scale with up-to-date machinery, it would be interesting and useful to find out whether the accumulation of stocks complained of by the Wood Products Company is due to overproduction by the Company itself or by others by indigenous methods, or whether it is due to reduced consumption. As regards the first point, we are addressing the Wood Products Company for information. Regarding the indigenous methods, it is not easy to get actual figures of production, but the slump in the market should be reflected in *katha* contracts in the divisions in which *katha* manufacture is carried out. Any information on this point from the Divisional Forest Officers concerned will be thankfully received by the Forest Economist, Forest Research Institute, Dehra Dun.

EXTRACTS.

FORESTS AND THEIR EFFECTS ON NATURAL PHENOMENA.

By D. D. Saigal, I.F.S.

Forests exert a good deal of influence on natural phenomena. The serious effects of disforestation throughout the centuries following the Aryan invasion of India resulted in a decrease of moisture which followed in parts of the country with a corresponding rise in temperature. The effect on the climate through this destruction was slow, imperceptible probably at any one period over any large area, but cumulative during the long period of nearly four thousand years. That in the time when India was covered with forests the climate was a more equable one is indisputable. Fa-Hian, the famous Chinese traveller in India in the fourth century A.D., says in describing the country, that its temperature was neither hot nor cold. No traveller could so describe it nowadays, nor would any European settler have so described it a century ago. In our own province where the prosperity of the rural population in the Canal Colonies depends on the continuity of flow of water in the rivers the problem of preserving the water in the hill catchment areas becomes of first rate importance. The vegetation on the hills acts as a sponge in holding rain water, and thus serves the purpose of a reservoir for the storage of water, which percolates through the sub-soil and again emerges in the form of springs and streamlets. The removal of this vegetation which is in rapid progress in most of the catchment areas results in serious repercussions in the streams and rivers in the forms of sudden floods of short duration. Thus we have the spectacle of villages washed away by rivers in flood during the rains and the same rivers so dry in winter as to seriously affect the water supply in the canals and the sub-soil water level in the surrounding country. The recent lowering of water level in the Jullundur Doab when the water level sank considerably roused great interest. Mr. Cotter of the Geological Survey of India attributed this lowering among other causes to decrease of rainfall perhaps partly caused by deforestation and also probably to disforestation in the adjoining Siwalik Range.

The destruction and havoc caused by floods during the monsoon months are too well known to need repetition. In America the problem became so serious at one time that a National Convention was called to devise measures to combat the evil. It was unanimously resolved to recommend that afforestation of the catchment areas of all the tributary streams and streamlets should be started and the evil nipped in the bud. The same conditions exist in the Punjab where the flooding of the five

rivers during the rains causes general dislocation. The Canal Department have super-passages constructed for the Budki and Siswan *Naddis* in the Ambala District to cross the Sirhind Canal. The Budki passage which is 395 feet wide and 14 feet high had the following floods :—

		Number of floods.	*Maximum flood, feet.*
1914	..	31	7·5
1925	..	31	8·3
1926	..	25	7·5
1927	..	21	10·4

The Siswan passage is 250 feet wide and 10 feet deep. In 1916, 1921, and 1927 the floods over-topped the sides of the passage. It is thus seen that with the deforestation of the Siwaliks, where the above *naddis* have their source the floods are getting of greater and greater intensity though less in number and of shorter duration every year.

Rainfall is another factor which is influenced by forests to a certain extent. The precipitation is quicker in a forest-clad than in a barren country. Enquiries into the question have been made from time to time but no conclusive results have so far been recorded by any country. There is scope for considerable research and exhaustive data are required to prove or disprove the existence of any influence of forests over the rainfall of the surrounding country. It can, however, be safely concluded that though the influence of existing forests on the climate may be doubtful there is no manner of doubt as to the harmful effect on the humidity of the surrounding country by the disforestation of the forest-clad hills.

BREEDING BETTER TREES

Seeds and pollen from selected trees of the world have been brought together in the greatest birth-control experiments ever attempted. America is rapidly but somewhat belatedly learning its lesson from the ruthlessness with which our forests have been depleted without thought for the future and a noteworthy attempt to rectify past errors is being made at the Institute of Forest Genetics, Placerville, California. Here, under the supervision of Lloyd Austin, Director of the Institute, experiments are under way which are directly aimed at increasing the rate of growth of various species of trees and, at the same time, improving the breed so that the resulting lumber may be more economically used.

As pointed out in the article on "Southern Pine for White Paper" on page 234 of this issue, paper production is one of the uses to which vast quantities of lumber are diverted. The experiments at the Institute may have a definite bearing not only upon the new source of pulp-wood mentioned in the article referred to, but also upon other types of trees which are potentially valuable for pulp.

At the present time 60 years are required to grow the average forest tree to saw-log size. If this growing time can be cut into two—if usable timber can be produced in about 25 years—we can save our forests from becoming completely denuded. Therefore, the workers at the Institute of Forest Genetics have searched the world for worthy parents from which to breed hybrid trees and thus select and promote desirable

characteristics of rapid growth as well as efficient foliage with few branches and a sturdy root system to withstand storms. Speed of growth is the first consideration, but the workers have not lost sight of other features that would make the wood applicable to many uses. Taking a leaf from other plant breeders, the men at the Institute leave nothing to chance in their work. Pollination is carefully controlled, the female flowers of an experimental tree being protected by bags during the pollination time, so that chance pollination cannot take place. At the proper time selected pollen is injected into the flower, possibly from a tree that grew on the other side of the world, and the resulting seed is planted and carefully nurtured.

Throughout the early period of growth, accurate measurements are taken and a complete record kept of all observations. Thus the tree breeders keep a check on results and know at all times how an experiment is progressing.

What will be the super-tree of America, that can withstand the rigours of winter, the ravages of insect pests, the blighting disease, and the heat and dryness of the torrid summers? It is still too early to say, but the work of this Institute is a step toward the solution of a pressing problem, and one which holds promise of brilliant results.—(*Scientific American, May* 1934.)

ROLE OF FOREST LITTER SHOWN BY STUDIES

BY E. V. JOTTER, CHIEF FORESTER.

Destruction of the forest with loss of valuable stands of timber is a cost of forest fires which is readily apparent. A less dramatic and less immediate cost than the burning of mature trees, but one which is of even more serious economic consequence is the greatly increased danger of soil erosion which is the inevitable aftermath of forest fires.

The function of trees as soil-builders has generally been recognised. The importance of forest cover in preserving the stability of the soil, and in absorbing and conserving rainfall has been conclusively established by experiment and research. On a slope stripped of its vegetative protection the run-off of water is unimpeded, and the soil is exposed to destructive force of erosion.

In California, for example, and in other regions where water is paramount in determining land use, this capacity of the forest cover to conserve rainfall is of especial importance. For much of our understanding of this function of the forest we are indebted to the researches of Dr. W. C. Lowdermilk.

The so-called "sponge effect," the capacity of forest litter to absorb water, was known and generally recognised when Dr. Lowdermilk's researches in China first made known the further function of the litter in keeping water clear, and in preventing the sealing of the earth's surface. Results of other of his studies conducted in California show that the amount of water running off of forest plots that had been burned over is much greater than for similar unburned plots. During one major rainstorm the run-off was 35 times greater from the burned area than from the unburned.

In the eastern hardwood region where there has been a great lowering of water tables, the researches of Dr. John T. Auten of the Central States Forest Experiment

Station is particularly significant, and should be of interest not only to those concerned with soil and forest conservation, but also to the farmers of the region, many of whom have been forced by the decreasing water supply to haul water for stock.

Dr. Auten's studies showed that the failure of springs and streams, the lowering of water tables and the failure of wells are closely related to decreased forest lands and to the poor condition of remaining woods. His experiments indicate that undisturbed woods (those in which there has been neither forest fires nor grazing) take up 3 to 9 times as much water as those which have been burned.

These two examples of research are representative of many other studies which show the importance of the forest cover in preserving the soil and in conserving rainfall. (*The Land, To-day and To-morrow*, January 1935.)

DEW PONDS

In England, where inscrutable relics of prehistoric man remain to intrigue the imagination of present day civilization, the dew pond remains as one usable invention, the origin of which is shrouded in the mists of antiquity. What are dew ponds, and what is the source of the water with which they are filled even in the driest of weather ?

The mystery of the dew ponds still remains ; and men are wondering to-day, as they wondered centuries ago, how and whence the water comes that fills those lonely hollows on the highest hills. On the bleakest ridges of the Sussex Downs, far from shade of tree or protecting copse, where no streams ever flowed, where no march has ever been, there, on those arid uplands, are found the dew ponds with the waters that never fail. Condensation of moisture of the atmosphere it may be, cooling into drops that merge into the pond in the chill night air, and so counteracting the evaporation under the summer sun. Go when we will, at all seasons of the year, there is water for the cattle or the sheep that roam the green downlands

The secret of the making of these ponds is known to but a few. The lime and flint to form the saucer-shaped bed, the layer of straw beneath the covering of clay, the final concrete surface, are all wrought with experience and craft that are a heritage from the past, and then left to dry. Once the pond has filled, though the clouds withdraw their shelter and no rains fall, though the torrid sun pour down its relentless heat by day, there will be the water for the cattle to drink.

It would be wrong to say that there are no dry dew ponds, for they are often to be seen about the Downs. But the reason is not far to seek. Once the bed of the pond is damaged, so that water can trickle through, the pond naturally fails. That is why many of these dew ponds are fenced, so that the heavier beasts cannot tread the surface, and only sheep are allowed access.

On the heights of Cissbury, not far from Worthing, may be seen the dry, shallow bed of a pond that has been broken up ; and the sheep in their wandering about the Downs visit this spot repeatedly, as though an instinct led them where water once had been. A mile northward across the same downlands at Chanctonbury, and not far from the well-known Chanctonbury Ring, there is a pond which cattle are allowed to use at will; and through the heat of summer they may be seen standing

knee-deep in the water; but already the concrete surface is so damaged that it can be but a little while before those much-needed waters fail.

Only a few new ponds have been constructed of recent years along the Sussex Downs, but westward, on the Marlborough and Wiltshire Hills, some have been added to the already existing number. There is no record of the making of the first dew pond, and the name of the discoverer of the secret has passed from human knowledge; but early dwellers in our land had their cave dwellings on the hills. On the highest portion of the Downs may still be seen the hollows where their pit homes were excavated, and it may be that these prehistoric folk learned the secret of securing the water they needed for themselves and their cattle on these exposed heights and that from them down a long succession of shepherds and hill-dwellers, there has come to us to-day the secret of the making of the " mist-pools " of the hills.

Arthur John Hubbard, M.D., and George Hubbard, F.S.A., F.R.I.B.A., in their book "Neolithic Dew Ponds and Cattleways" (1907) give the following complete description of a dew pond:—

"We are not aware that the thermo-dynamics of a dew pond have ever been elucidated, and it is evident that this cannot be done until the construction of such a pond is understood. There is in this country (England) at least one wandering gang of men (analogous to the mediæval bands of bell-founders, masons and so forth) who will construct for the modern farmer a pond which, in any suitable situation in a sufficiently dry soil, will always contain water. This water is not derived from springs or rainfall, and is speedily lost if even the smallest rivulet is allowed to flow into the pond.

" The gang of dew pond makers commence operations by hollowing out the earth for a space far in excess of the apparent requirements of the proposed pond. They then quickly cover the whole of the hollow with a coating of dry straw. The straw in its turn is covered by a layer of well-chosen, finely puddled clay, and the upper surface of the clay is then closely strewn with stones. Care has to be taken that the margin of the straw is effectively protected by clay. The pond will gradually become filled with water, the more rapidly the larger it is, even though no rain may fall. If such a structure is situated on the summit of a down, during the warmth of a summer day the earth will have stored a considerable amount of heat, while the pond, protected from this heat by the non-conductivity of the straw, is at the same time chilled by the process of evaporation from the puddled clay. The consequence is that during the night the moisture of the comparatively warm air is condensed on the surface of the cold clay. As the condensation during the night is in excess of the evaporation during the day, the pond becomes, night by night, gradually filled. Theoretically we may *observe that during the day, the air being comparatively charged with moisture,* evaporation is necessarily less than the precipitation during the night. In practice it is found that the pond will constantly yield a supply of the purest water.

" The dew pond will cease to attract the dew if the layer of straw should get wet, as it then becomes of the same temperature as the surrounding earth, and ceases to act as a non-conductor of heat. This practically always occurs if a spring is allowed to flow into the pond, or if the layer of clay (technically called the ' crust ') is pierced."

In *Scientific American Supplement*, Number 1692, 6th June 1908, Edward A. Martin, F.G.S., took quite apparent exception to the conclusions of Messrs. Hubbard, basing the majority of his statements on the theory put forth (and at that time apparently widely accepted) that " dew is really formed from the moisture which rises out of the soil with the radiation of heat, and that it is this which is precipitated when the air into which it passes has been so reduced in temperature as to be unable to hold it as aqueous vapour. If this theory be the correct one," continued Mr. Martin, " it would at once dispose of the suggestion that dew ponds are fed and filled by true dew . . . "

Reference to the pages of " Physics of the Air," by W. J. Humphreys, C.E., Ph. D., tends, however, to uphold the theory of Messrs. Hubbard in the following statement:—

" *Dew*, water that has condensed on objects that by any process have attained a temperature below the current dew point of air immediately in contact with the bedewed objects. The cooling necessary to the formation of dew usually results from the loss of heat by a radiation."

Whatever the source of the constantly replenished water in the dew ponds of England, certain facts appear to be irrefutable:—The ponds do exist, and are constantly refilled, even though no rain falls. If the surface that holds the water is broken, the water drains off and the pond becomes dry.

What the true explanation of dew ponds really is must await an open-minded and scientific series of experiments on a large scale. Whether or not these ponds could be successfully constructed in this country is problematical; we should be glad to hear from any one who may make the attempt, and to receive data on the exact procedure followed and the results obtained.—(*Scientific American*, May 1934.)

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SEED COLLECTION AND HEREDITY

We publish Mr. Joshi's article in the hope that it may result in some discussion of this most important matter in the pages of the *Indian Forester*. From reading the article one might obtain the impression that this subject had been entirely neglected in India up to the present time. This is hardly the case. More than 15 years ago expression was given to the view that the characteristics of the mother trees were transmitted to their off-spring; much to the amusement of many people who considered that such a statement showed signs of incipient insanity. Considerable thought has been given to this matter at the F. R. I. where different races of teak, kusam and khair are under investigation as well as the inheritance of figured wood. Champion's researches carried on for many years have shown that twist in chir is transmitted through the seed. An experiment in the inheritance of the growth forms of sissoo was ordered some years back in the Punjab and the question of the inheritance of high resin production is also under investigation. There is no reason whatever why by careful selection we should not be able considerably to increase the resin yield of chir, in the same way as the production of rubber has been increased by selection.

Silviculturists should be able to give a certificate of origin and it might be possible to grade the seed. With all systems employing natural regeneration, however, the proper selection of the mother trees and the elimination of the unfit throughout the life of the crop will ensure robust and virile regeneration from the best parents. This we have advocated for many years not always with great success.

SEED COLLECTION AND ITS IMPORTANCE TO INDIAN FORESTRY

BY K. D. JOSHI, I. F. S.

The principle of genetics as applied to forestry is of a comparative recent date although this principle has been accepted and followed earlier in the cases of fruit culture, food grains, cotton-growing and sugarcane production. Its application to the animal kingdom has been accepted from pre-historic times.

An average forester has even now a very poor idea of seed selection. He is satisfied if he can collect enough seed for his needs. All that he asks for is the quantity of the seed and not the quality. At the utmost if he ever considers himself as a cautious collector, he insists on the seed to be collected from off the tree instead of being picked up from the ground. Our best foresters appear to be content when they have made the seed to go through the test of germination. If the germination percentage is high they consider themselves quite lucky. The most important fact of the "provenienz" as it is called in Europe meaning the province or locality from which the seed is collected, is completely lost sight of and never considered. Scientific forestry needs much more than quantity of seed collected. The germination test is no doubt a necessary corollary of a good seed but it should come after and not before "provenienz." The fact must be borne in mind that the forest trees follow the ordinary genetic rules and behave exactly as the other food crops do or even as the animal kingdom does. In Europe it has now been established that there is always a great influence on the future of a forest crop due to the origin, form or rate of growth of the parent tree. Even as early as towards the end of the eighteenth century French foresters demonstrated the effect of seed on the future of a forest crop. Since then several foresters in Germany, Russia, Austria and other European countries carried out important research work and proved that—

1. A species has different races due to its adaptation and aclimatisation to the peculiar conditions of the climate of a locality through

selection during many generations. These racial characteristics then become hereditary.

As the climate varies so much on altitude and other factors, the racial characteristic also vary with it. Through a natural selection carried on for many generations a species develops particular characteristics suited to the climate of the place.

The altitude plays a large part in the growing season of the plants. The higher the altitude the more limited is the growing period for a plant. Every plant has to put on its maximum growth rapidly in order to keep pace with the limited period of sunshine available. Autumn conditions set in earlier and the plant has to stop growth to avoid the rigours of the winter.

Aspect also plays an important part in this selection and formation of peculiar characteristics of a race. There are several other factors, too numerous to mention here, in bringing a species to form certain definite habits in order to form a race. In course of time these races form definite species but that is a different matter and does not concern us here.

What is most important to bear in mind is that seed, if not selected according to the altitude and other factors, is liable to produce results not desirable otherwise.

When seed is to be introduced from outside, the following facts should be considered :—

(*a*) Seed from a high elevation if brought to a low one does not develop so quickly as in its own habitat and *vice versa*.

(*b*) The low elevation seed growing at a higher elevation starts growth later and carries on growth late in the season till it is caught by frost.

(*c*) The high elevation seed introduced at lower levels, on the other hand, starts growth earlier in spring as it needs lesser heat and thus gets caught by night frost in spring.

(*d*) At high elevations species develop thicker bark and are less liable to mechanical injury than those from low elevations if introduced higher up.

2. The form of a tree is also inherited. A low branched tree with a short bole would obviously be an undesirable parent tree to take the seed from if a straight long bole for timber production is aimed at.

3. The rapidity with which a tree grows is also an inherited quality. Seed therefore should not be collected from slow growing trees and as stated above if seed is brought from different altitudes, it shows lesser growth and would therefore be again undesirable.

Standing orders should be made for selecting trees from which seed is to be collected and they should lay emphasis on the fact that —

(*a*) Seed should be collected locally as far as possible. If this is not practicable it should be from a similar climate, altitude, aspect, etc.

(*b*) After selecting the "provenienz" or locality, the supplies should be from straight-grown healthy trees, and

(*c*) Low crowned trees should be avoided and so should the branchy ones growing in the open.

Unless these factors are borne in mind every time that seed is collected, the future of a forest crop will give depressing results. Strict control over seed supply is absolutely necessary if our aim is to grow a good healthy forest crop. As forestry is not a matter of a few years to give results, any slackness in the matter of seed selection would almost be a national calamity. Strict regulations should always be made for seed collection and its distribution. Our aim should not be the collection of a certain quantity of seed but quality is what we should aim at. Unless foresters look ahead, they cannot expect to obtain better results for posterity. In agriculture and other allied branches, results are obtained quickly within a few years and mistakes can be rectified within one's own life-time but forestry is a subject where once a mistake is committed in the wrong selection of seed, the future of the crop suffers. There has been a tendency among forest officers to collect seed anyhow and from anywhere so long as they can sow certain areas within a limited time.

No forester should rest contented until he has personally or through equally accredited agents made an inspection of the locality and the growing stock from which the seed is to be collected. The person directly responsible for supplies should understand the importance of his task. He would be shirking a great responsibility if bad seed goes out of his hands.

In the Western countries like Switzerland, Sweden and Norway, they have started important seed testing stations run and controlled by the State. The Governments of these countries consider it as one of their duties to test the seed before it is sent out for sowing. All unauthorised seed is strictly forbidden to be used by anybody inside the country. The laws are strictly enforced.

It should be the aim of the indian forester, therefore, not to rest until he has made his Government feel the necessity of controlling the seed supply in this country. Every Province should have its seed testing station run on efficient and up-to-date scientific lines. It should be placed in a central position and no seed either for private or for State forests should be available for use unless it is passed as suitable by this station. It would not be difficult to adopt this in practice as most of the Provinces have their own silviculturists who could efficiently do this work in addition to other duties. Very small outlay in starting these testing stations would, therefore, be necessary. For the future of our forests, at least wherever large afforestation works are undertaken, no seed should be used unless it has been through approved tests.

It might take time to educate the public in this matter and the Government may take time to realise the seriousness of the problem and to make necessary laws, but the duty of every forester should be not to neglect this important matter.

Several foresters in India have considered the importance of seed collection and Mr. H. G. Champion, the Imperial Silviculturist at Dehra Dun, in one of his notes published in the *Indian Forester* has lately drawn the attention of foresters again to this matter. Every Province should insist that any slackness in the matter of seed collection would not be tolerated. In cases when seed has to be

imported from one province to another the suitability of the seed for a certain locality should always be ascertained first before introduction. All large scale afforestation works should have this as their first and most important item or else the posterity would label these works as so much wasted effort.

Plants in the earlier stages may appear to answer the purpose but if seed is not properly selected they cannot make good timber nor would they be suitable for future propagation. The loss, therefore, to the State by bad choice of seed would be a serious matter and such as would become irreparable. Without going into details of much research work that is needed on choice of species, ecology, etc., it would serve our purpose if the following rule is placed before every forester:—

"Select seed from a good healthy tree locally and if not obtainable, obtain it from a similar climate."

Dated PAURI, GARHWAL:
July 25, 1935.

Reference.

MacDonald, J. A. B.—Genetics and British Forestry—The *Scottish Forestry Journal* (October 1930).

THE PUNJAB FOREST CONFERENCE, 1935.

19th—23rd February.

The Conference opened on the 19th February, the Chief Conservator of Forests, Punjab and N. W. F. Province, presiding. Papers on problems in irrigated plantations, management, propaganda work, game preservation, ecology of chil and silver fir regeneration were read and discussed. The Conference was also fortunate in getting Dr. Mackenzie Taylor of the Punjab Irrigation Research to deliver an address on soil types with special reference to his studies of the Kulu forest soils in collaboration with the Forest Research Division.

In the following lines are summarised only the salient points of the different papers and the discussions thereon.

1. *Dr. Taylor's address on soil types.*

Dr. Taylor explaining the derivation of soil types classified the main determining factors as (*i*) rock, and (*ii*) climate. Soils in which parent rock determines the characteristics—technically called endodynemomorphic soils—are divided into (*a*) Skeletal, and (*b*) Rendzina types. The other soil groups—ectodynemomorphic—are developed under varying conditions of temperature and rainfall. Podsols are found in cold climates. As temperature increases the brown earth, the yellow and red earth and finally the laterites are produced. In addition local types occur under purely local conditions.

Soil profiles are divided into zones, "A" is that from which the materials have been removed by leaching, "B" in which they have been deposited, and "C" the material similar to the parent rock. These zones are further sub-divided by difference in colour and texture.

In Kulu podsols, brown earth, ground water soil and Rendzina types were all met with. The Kulu podsols, however, differ from the standard types by the high degree of saturation in the A_0 and A_1 horizons and their consequent high PH value. This is accounted for by the continuous addition of needles from the trees—needles which were found on examination to have more than 40 per cent. calcium oxide. Deodar occurred on the best developed profiles, so did blue pine, but in the latter case the soil was "thin" with boulders distributed throughout; spruce occurred under a wide range of conditions and chil on the least developed soils.

2. *Problems of irrigated plantations—N. P. Mohan.*

The chief problem in Khanewal and Miranpur plantations is the selection of species and races suitable for cultivation in frosty, *dub* invaded and sandy areas together with the area irrigated by the Sutlej Valley Project characterised by the late supply of water for only short period. In this connection an intensive study of climatic and edaphic factors, particularly in relation to the varying demands of the races of different species, proved valuable. The following species were suggested as suitable for trial:—*Melia azedarach* and

Cordia obliqua, in blanks, *Kydia calycina* as cover crop, *Schinus terebinthifolius*, *Rhus lancia*, *Ipomaea carnea* and *Adhatoda vasica* in *dub* invaded areas; *Parkinsonia aculeata*, *Prosopis juliflora* and *Acacia farnesiana* in sandy soils. On *kallar* soils and grass-invaded areas closer trenches were suggested as a remedy. The exclusion of poor areas was also considered but was found to be impracticable. No very definite conclusion was arrived at.

3. *Propaganda amongst the villagers in Hoshiarpur—K. S. Malik Allah Yar Khan.*

The Hoshiarpur Division was faced with three outstanding difficulties, *viz.*, (*i*) reckless fellings in *shamlats*, (*ii*) incendiarism, and (*iii*) erosion. Propaganda amongst the villagers was considered as the suitable remedy. The *modus operandi* of this propaganda consisted of short tours in the villages and holding of meetings in which the advantages of forests and soil cover as well as the dangers following deforestation were explained. This had the desired effect as the people themselves began to apply voluntarily for the closure of areas against grazing and took to tree planting. It was held that a good deal of the trouble was due to obscure and complicated forest settlements in which the rights of the parties were not clearly recorded. The situation was aggravated by the exasperating effect of criminal proceedings into which the people were drawn for forest offences, other contributary causes were quarrels amongst villagers, lack of respect for collective property and abuse of powers of grants by *lambardars*. It was suggested that something more was required in addition to propaganda, namely a definite policy which would permit of the creation of village forests to be managed by the village committees and *panchayats*.

Propaganda would, however, be of no use in Rawalpindi and Hazara where people were stubborn and suspicious.

4. *Chil types in Hazara—Bashir Ahmed.*

The types distinguished were :—

(*i*) *Kail-oak type*—(6,000′—6,500′). A transition type.

Among oak species *Quercus incana* is the commonest and the

most important on account of its rôle in helping the spread of blue pine. Other associates :—*machilus, parrotia, berberis* and *lonicera.*

(*ii*) *Grass type.*—(3,000′—6,000′). This is the most highly developed and stable type in which chil attains its highest quality. Tree associates : *Quercus incana, Pistacia, Machilus* and *Alnus* all scattered individually or confined only to nullahs. Probably ban oak forest is the climatic climax though not attained in the locality due to the disturbing effects of biotic factors. Undergrowth, almost wholly grasses which are favoured by low but frequent rainfall. This type is further sub-divided into *indigofera* and *woodfordia* sub types, the former occurring above an elevation of 4,500′ on lands subjected to heavy grazing and the latter at 3,000′ confined mostly to southern aspects.

(*iii*) *Berberis myrcine type.*—Found exclusively in Khanpur in cooler situations with a reasonable depth of soil. Other associates: *Cornus, Ficus palmata* and *Olea cuspidata.*

(*iv*) *Carrisa-dodonea type.*—(3,200′—3,800′) on shallow soils. Other associates : *Grewia, Mallotus, Celtis* and *Casearia.*

(*v*) *Dodonea-woodfordia type.*—Confined to southern aspects in situations of extreme insolation.

The important ecological factors are rainfall, topography, geology and the biotic factor, the last one is of special significance on account of the history of the district. With regard to the comparability of these types with the Kangra types it was held that this could not be done at this stage of our knowledge. The vegetational covering was very plastic and variations in its composition in different localities took place in response to changes in environmental conditions.

5. *Game Preservation and Sanctuaries—A. M. David.*

The paper contains a well reasoned appeal for the protection of wild life as Nature's gift, valuable not only for æsthetic purposes but also for scientific research and sport. It also deals with the existing legislation for the protection of game and the New Punjab Game Act which came into force in September 1934 and which lays down, among other things, the issue of various licences for shooting or capturing

game outside the forest limits and prohibits the possession of game birds or animals (except those mentioned in the schedule) in the closed season. The new game rules are still in their infancy and it will take some time before any results are obtained which will depend mostly on the extent to which the rules are enforced. The check of abuse of licenses as well as the restriction of their numbers will be in the hands of Deputy Commissioners and not of the Forest Department. A strong case is made for the formation of sanctuaries "where wild life can live and breed, safe in the knowledge that they will not be hunted, shot and trapped."

The shortcomings of the new legislation are believed to consist in the few powers given to forest officers which are confined merely to lodging complaints, and the lack of legally recognised right of private ownership in game which deprives the owner of the land of the ownership of game.

6. *Reasons for partial reversion to Selection System in Pabar— K. L. Aggarwal.*

The chief reasons adduced were the abnormality in age classes, numerical and spacial, plus the broken nature of the ground. This irregularity in age classes was due mainly to the devastating effect of forest fires in the past. One more reason in favour of reversion to the Selection system was its special suitability for the production of big timber. The controversial part of the paper was that relating to the elasticity provided in permitting in actual practice shelterwood fellings in areas allotted to the Selection Working Circle. This was, however, justified as a modification of the Selection system to allow of the proper treatment of patches of regular type which occur throughout the forest, although irregularity was recognised as a permanent feature of these forests.

7. *Reasons for the premature revision of recent working plans— A. P. F. Hamilton and N. G. Pring.*

This paper purports to be a continuation of the paper on the Punjab Shelterwood system contributed by Mr. H. M. Glover, Conservator of Forests, in the Punjab Forest Conference of 1931. The

failure of the working plans is attributed to a number of causes, *e.g.*, failure of regeneration to keep pace with the fellings, inclusion in volume yield of a large quantity of unmerchantable growing stock, incendiarism, grazing difficulties and unsatisfactory arrangement for right holders' demands.

To avoid breakdowns in future the suggestions made are :

(*i*) Proportionate reduction of yield in the case of appreciable reduction of capital stock as a result of fires.

(*ii*) Combined yield for controlled species.

(*iii*) Three-year felling programme.

(*iv*) A periodic allowance for heavy periodic increment.

(*v*) The use of expedients such as a long or flexible regeneration period, alternative optional yield, and combined yield from P. B. I. and other blocks.

(*vi*) Control of regeneration by periodic assessments.

(*vii*) Calculation of yield in terms of merchantable timber ignoring increment.

(*viii*) Adequate provision of grazing requirements.

The reason why the Selection plans in the past had relatively long lives was that failure in the Selection system did not attract so much notice as under the system of concentrated regeneration.

The causes responsible for the breakdown could be classified into primary and secondary, the former included the calculation of yield from only part of the growing stock of the working circle and failure of regeneration to keep pace with fellings. The secondary causes were incendiarism, inadequate provision of rights, etc. As it was impossible to forecast the occurrence of fire, a very important secondary cause, it was necessary to incorporate in the working plans provisions on the lines suggested to avoid their breakdown. The suggestion for fellings in P. B. II was considered a controversial matter but it was emphasised that although it is best to avoid these fellings it was undesirable categorically to exclude them from consideration. The 3-year felling programme was considered to be a sufficient guarantee against the abuse of such fellings. Distinction

was made between the status of the felling rules and the other prescriptions of the plans. In so far as the former were excluded from the summary of prescriptions embodied at the end of the plan, they could not be considered on parity with the latter, being only of the nature of suggestions. This provided the much needed flexibility to the executive. This paper and the 1931 paper referred to above are being printed as Punjab Forest Records and will repay study as they form the basis of current practice in the forests of the Punjab Himalaya.

8. *Results of Silver Fir seed year of* 1932—*I. D. Mahendru.*

In pursuance of the resolution of the 1933 Conference a record was maintained of the influx of regeneration from the 1932 seed year in the hill divisions. In addition observations were recorded in the experimental plots of the Research Division.

In the Galis Division the regeneration was reported as making "slow and steady progress." The inimical factors included thick humus, strobilanthes and excessive grazing.

In the Lower Bashahr Division results were considered as disappointing, natural seedlings appeared only where fire and exposure had made conditions favourable or on small areas where humus was not more than 2″ thick and seed-bearers 50′ to 60′ apart.

In Kulu a phenomenally large number of seedlings was observed, particularly in Bandag C. 2 where seeding fellings were not bright and débris was burnt.

In the Research Division, the best results were obtained under clear felled vertical strips, 50′ to 75′ in width and the next best under a moderately open canopy of seed bearers 30′ to 50′ apart.

As regards soil treatment it was found that success was in proportion to the intensity of soil working or burning. However, where burning was done, different intensities of soil working did not have any significant effect on the influx of regeneration.

RESOLUTIONS OF THE CONFERENCE.

The following resolutions were passed :—

Resolution No. 1.

This conference thanks Dr. Mackenzie Taylor for having shown and explained soil profiles collected in Kulu Division and hopes that he will be able to continue this useful study.

Resolution No. 2.

That the conference is firmly of opinion that the state of the undemarcated forests is so deplorable that the present policy for their management must be changed. The practicability of forming village forests should be examined, and Government may kindly be asked to appoint a committee to decide what particular steps should be taken in each district of the outer Himalayas.

Resolution No. 3.

Resolved that the paper of Messrs. Hamilton and Pring be printed as a special Punjab Forest Publication. The authors have agreed to modify certain conclusions in view of the discussion during the conference.

Resolution No. 4.

That Mr. Glover's paper " Some notes on recent changes in Forest Management in the coniferous forests of the Punjab-Himalayas with special reference to the shelterwood compartment system " be printed as a separate " Punjab Forest Publication."

Resolution No. 5.

Resolved that a committee be formed to investigate, in consultation with the Game Warden, what steps can be taken to provide better protection of game in Reserved and Protected forests and what modifications, if any, are required in the present hunting and shooting rules.

Resolution No. 6.

Resolved that observations on the regeneration of fir shall continue in all high hill divisions on standardised lines with a view to assess progress.

METAL SPRAYING OF WOOD.

AN INVESTIGATION INTO THE MOISTURE AND SHRINKAGE RETARDING EFFECT OF METAL SPRAYING ON WOOD.

BY S. N. KAPUR AND AZIZUL REHMAN,

Wood Seasoning Section, Forest Research Institute, Dehra Dun.

1. INTRODUCTION.

Metal spraying is the process by which any metal or alloy capable of being drawn into wire and of being melted in any oxy-coal gas, oxy-hydrogen or oxy-acetylene flame is deposited by means of a special pistol on metal, wood, celluloid, paper, texile fabrics or any other surface. The process is coming into considerable importance for the deposition of various metals *in situ* on small and large structures to prevent corrosion due to atmosphere, moisture, heat and other causes. The metal, which is fed to the pistol in the form of a fine wire, is melted in a blow-pipe flame, and the molten metal is sprayed by means of a compressed air jet. The heat generated by the flame is dissipated by the compressed air, so that there is visibly no detrimental effect of heat on the surface to be coated. A slight roughness of the surface is necessary, this can be obtained by sand-blasting and is considered indispensable even in the case of wood and millboard. It tends to raise the natural grain of the wood, which is essential for a good adherence of the metal film to the wood surface.

2. OBJECT OF THE INVESTIGATION.

The object of our experiments was to find out how far a film of metal sprayed on a piece of wood would protect it against changes in moisture content and dimensions due to variations in atmospheric humidity. For various purposes it is necessary that the hygroscopicity of wood should be reduced as much as possible, so as to reduce its "working" to a minimum. Since the process of metal spraying is stated to be easy to carry out and is claimed not to be very costly, it was considered of interest to find its utility in this direction. The actual work of spraying various samples of wood with different metals was kindly undertaken by Messrs. Allen-Liversidge (India) Ltd,

of Bombay, who are the sole agents for the process in this country and who have a demonstration plant at Bombay.

3. Test Material.

One air seasoned plank or scantling, about 2 feet in length, of each of the following six species was selected and was cross-cut to give four specimens. Moisture sections were taken at the ends and in between the various specimens. All the specimens were weighed and measured immediately after cutting and the two alternate ones were kept untreated as controls, and the other two were sent to Bombay for metal spraying. The table below gives information about the species, dimensions of the specimens, and the kind and weight of metal sprayed on them. In all, there were 12 treated and 12 untreated specimens under observation in this test.

Table I.

Particulars of treated specimens under test.

Specimen No.	Species.	Dimensions. Length Cm.	Width Cm.	Thickness Cm.	Surface area Sq. cm.	Metal sprayed. Kind.	Total weight Gm.	Grammes* per 1,000 Sq. cm.
2	Teak (*Tectona grandis*)	12·5	10·2	2·4	364·0	Tin	43·1	118
3	Ditto ..	14·7	12·2	2·7	503·9	Zinc	67·0	133
6	Haldu (*Adina cordifolia*) ..	15·4	10·8	2·4	458·4	Lead	107·5	235
7	Ditto ..	15·3	10·7	2·4	452·2	Aluminium.	11·2	25
10	Sissoo (*Dalbergia sissoo*) ..	15·7	10·2	2·6	455·0	Copper	44·3	97
11	Ditto ..	15·3	10·2	2·6	444·7	Zinc	39·6	89
14	Indian Rosewood (*Dalbergia latifolia*)	15·4	11·0	2·7	481·4	Bronze	55·2	115
15	Ditto	15·2	11·0	2·6	470·6	Tin	39·6	84
18	Gurjan (*Dipterocarpus alatus*) ..	15·3	5·1	5·1	364·1	Brass	21·9	60
19	Ditto ..	15·2	5·1	5·1	362·1	Lead	58·5	162
22	Andaman padauk (*Pterocarpus dalbergicides*) ..	10·3	8·7	8·7	509·8	Lead	126·4	248
23	Ditto ..	10·5	8·7	8·7	516·8	Bronze	94·5	183

*To obtain the values of metal deposited on wood in pounds per sq. ft. multiply the figures in this column with the factor, 0·0205.

The samples for treatment on receipt by the firm in Bombay were slightly sand-blasted, weighed, sprayed with different metals and reweighed before return to Dehra Dun, where these specimens were again measured and weighed and were then tested along with the untreated controls in the manner described below. The appearance of the treated pieces was that of dull matte finish, with slight unevenness of the surface caused by sand-blasting. The thickness of the coating appeared to be more or less uniform, except at the ends, where in some cases it was fairly thick. The coating seemed to be continuous, without any visible cracks or breaks. The colour of the pieces varied with the metals used. The original colour, grain and figure of the wood were, however, entirely masked.

4. METHOD OF TESTING.

(*i*) *Moisture equilibrium values.*—After a few days' conditioning in the air, all the specimens were placed in a constant humidity chamber, running at a temperature of 95° F., and a relative humidity of 72 % in which they were allowed to attain equilibrium for about a month, when they were again weighed and measured. The specimens were then transferred successively to chambers running at 53 %, 30 %, 50 % and 90 % relative humidity for determining equilibrium values at these humidity conditions.

(*ii*) *Rate of moisture loss and shrinkage.*—After the cycle described above was over, the specimens were transferred from 90 % to 30 % relative humidity, and they were weighed and measured daily in order to find out the amount of retardation in the rates of moisture loss and of shrinkage as compared with the untreated controls.

(*iii*) *Absorption of moisture under a spray of water.*—In order to determine the suitability of metal spraying of wood for outside locations, some of the specimens along with the corresponding controls were exposed to a fine spray of water for periods varying from half an hour to two hours every day for 3 days, followed by air seasoning.

(*iv*) *Water soaking.*—The rest of the specimens, which were not exposed to the action of water spray, were soaked in water, and left immersed in it for 8 days, during which period they were frequently weighed. This test was carried out to determine the resistance of

sprayed metal coatings to penetration by water in the liquid state. Finally some of the pieces were subjected to a vacuum of 26 inches for $3\frac{1}{2}$ to 5 hours while immersed in water.

5. Discussion of results.

Due to the diversity of factors involved in the experiment, there being six species of wood and seven kinds of metal under test on 12 specimens, and with wide variations in the amount of metal deposited on different specimens, it is hardly possible to draw any exact conclusions from the present investigation ; but there are broad indications from which some fairly definite inferences can be made.

The results of the first two tests, namely, the average change in weight and size of the specimens at equilibrium values at various relative humidities, and the rate of moisture loss and shrinage for 1 to 6 days are summarised in Table II. The figures given are in the form of percentages of corresponding values for untreated controls. For example, the specimen No. 2 of teak, when transferred from a relative humidity of 90 % to 30 % lost 1·0 % in moisture content in one day, as against 3·0 % in the case of untreated control, and its percentage change in weight is given as 33·3 %. It is obvious that the smaller this figure, the greater is the efficiency of that particular coating.

TABLE II.

Changes in weights and dimensions of treated pieces, expressed as percentages of the corresponding values for the untreated controls.

Specimen No.	Wood.	Metal sprayed. Kind.	Metal sprayed. Grammes per 1,000 sq. cm.	Percentage loss in weight from 90% to 30% relative humidity: 1 day.	3 days.	6 days.	Percentage change after attaining equilibrium conditions in. Weight.	Width.
2	Teak ..	Tin ..	118	33·3	50·0	52·2	56·5	50·1
3	Do. ..	Zinc ..	133	37·5	42·3	52·8	62·1	63·1
6	Haldu ..	Lead ..	235	48·0	54·1	67·4	67·8	60·9
7	Do. ..	Aluminium ..	25	84·6	84·2	90·9	91·9	85·1
10	Sissoo ..	Copper ..	97	72·7	77·4	82·1	91·2	79·4
11	Do. ..	Zinc	89	54·5	61·3	71·4	79·8	79·7
14	Indian rosewood	Bronze ..	115	75·0	69·2	82.4	78·8	65·5
15	Do. ..	Tin ..	84	66·7	64·3	73·7	73·9	65·3
18	Gurjan ..	Brass ..	60	100·0	103·3	100·0	97·3	88·5
19	Do. ..	Lead ..	162	50·0	56·3	66·7	79·2	74·2
22	Andaman padauk.	Lead ..	248	20·0	34·0	45·4	71·0	68·3
23	Do. ..	Bronze ..	183	76·9	77·3	87·9	93·5	85·8

From the above Table, it would appear that metals with low melting points, namely, tin, lead and zinc, are more efficient in protecting wood against changes in moisture content and dimensions than metals with high melting points, namely, copper, brass, bronze and aluminium. Practically similar results were obtained in the water soaking tests, given in Table III. The metals having high melting points, when sprayed in the usual manner are already known to give porous coatings. Turner and Bugden in *Metal Spraying** state that "it has been impossible to make coatings of aluminium, copper, brass and the higher melting point metals non-porous by means of the pistol alone." They† suggest the employment of various mechanical, heat and chemical treatments to increase the solidity of the metal film, but none of these treatments are applicable to wood, and the metals with high melting points are, therefore, useless for spraying on wood, if the object is to protect wood against moisture changes.

Referring to Table II, tin coating on teak has given better results than the same metal on Indian rosewood. Similarly zinc appears to be more efficacious on teak than on sissoo. These differences are evidently due partly to the thickness of the metal film, as the coatings on teak are heavier than those on specimens of the other two woods. Lead with approximately the same amount of metal sprayed per 1,000 sq. cm. gives more efficient results with Andaman padauk than with haldu, which is chiefly due to the difference in the moisture absorptive capacity of these two woods. The results briefly stated indicate that tin, lead and zinc coatings in the thicknesses as used in this test bring down the hygroscopicity and shrinkage of wood specimens to about one-third to one-half as compared with untreated wood. It may be mentioned that some of the paints and varnishes, which cost much less, possess a distinctly higher efficiency in this respect. Copper, brass, bronze and aluminium are, as already stated, practically ineffective.

The results obtained by soaking in water for 8 days are shown in Table III.

* *Loco cit*, page 69.
† *Loco cit*, page 103.

TABLE III.

Amount of water absorbed by treated specimens as percentage of the corresponding untreated controls.

Specimen No.	Wood.	Metal.	PERCENTAGE WATER ABSORBED IN	
			2 days.	8 days.
3	Teak ..	Zinc	87	69
7	Haldu	Aluminium	103	112
10	Sissoo	Copper	144	110
15	Indian rosewood ..	Tin	133	127
18	Gurjan	Brass	111	178
22	Andaman padauk ..	Lead	85	78
23	Do. ..	Bronze	114	95

It may be seen from the above Table that the amount of water absorbed by the treated specimens was in most cases considerably in excess of that for the untreated controls. Possibly the metal films themselves have a large area of capillary surface, which tends to increase the amount of water absorbed by the wood specimens. Here also lead and zinc have stood better than copper, brass, bronze and aluminium, although tin did not do so well as in the humidity tests. Experiments with soaking under a vacuum showed more or less similar results. When the specimens were placed under a spray of water for short periods, the absorption of water by the specimens was negligible both in the case of the treated and the untreated pieces.

There is one great disadvantage with the metal spraying of wood, namely, the cracking and breaking away of the metal film in course of time due to alternate swelling and shrinkage of wood. Some of the metal coatings, for instance, those of aluminium, brass and lead were found to crack, which ultimately leads to the peeling off of part of the coating, particularly from the ends. In others, when the

films expanded with the swelling of the woods, the coatings were found to have a somewhat wrinkled appearance after the specimens were again air seasoned. Due to alternate swelling and shrinkage of wood with changes in atmospheric humidity, the adherence between the metal film and the wood surface becomes weak in course of time, which leads to the deterioration of the metal film. Particularly in exposed situations, the metal sprayed wood would have a very short life.

6. SUMMARY.

1. Metals having low melting points, like tin, lead and zinc, when sprayed on wood, reduce its susceptibility to changes in moisture content and dimensions due to variations in atmospheric humidity by about one-half to one-third.

2. Metals melting at higher temperatures, like bronze, brass, copper and aluminium, do not protect wood appreciably against fluctuations in atmospheric humidity.

3. Sprayed metal coatings do not protect wood against absorption of water during soaking of treated pieces in water. On the other hand, the amount of water absorbed is increased in most cases.

4. Frequent swelling and shrinkage of wood weaken the bond between the metal film and the wood surface, causing cracking and later peeling off of the metallic coating.

ECONOMIC RESULTS OF THE APPLICATION OF A NEW PRINCIPLE OF FLUID IMPREGNATION INTO POROUS MATERIALS TO THE PRESERVATIVE TREATMENT OF CHIR AND BLUE-PINE RAILWAY SLEEPERS

By S. Kamesam, M.I.E. (Ind.)

Officer-in-Charge, Wood Preservation Section, F. R. I., Dehra Dun.

The principle in question and the experimental data obtained by its application to *chir* pine sleepers have been included in a Railway Board Technical paper (No. 271) published in 1929, and, later, in a more developed form, in a paper submitted by the writer to the Indian Institution of Engineers.

The situation at the time the research was undertaken, in 1928, was as follows :—

Three to four lakhs of *chir* and blue-pine (kail) sleepers were being purchased annually by the North Western Railway (since 1923) for antiseptic treatment at Dhilwan.

In 1928, the North Western Railway's specification for the purchase of *chir* and blue-pine sleepers included clauses which not only limited the maximum sapwood content in any individual sleeper to 25%, but insisted also on one broad face being entirely of heartwood.

As a result of these two restrictions, it was estimated that about 45 to 50% of sound serviceable timber in pine logs felled for conversion into sleepers was cut out and rejected in the forest. The rejected timber was all sapwood which is accepted to be as strong as the heartwood for the same moisture content, but is much more porous than the latter. Such a loss was stated by previous experts to be unavoidable.

It may be explained that the two restrictions in question were based on the opinion held previous to the writer's work that it was hardly possible to treat together to refusal (under pressure) materials of such widely varying degrees of porosity as *chir* or blue-pine sapwood and heartwood so that the sapwood and the heartwood of the two pines would retain about the *same* quantity of antiseptic oil at the end of the processing. The gross absorption in the sapwood was found to be four to five times as much as in the heartwood. As the application of the new principle made it possible for the first time to treat a 100% sapwood sleeper along with a 100% heartwood *chir* pine sleeper in the same charge under identical pressure conditions, obtaining at the end practically the same *net* absorption in both the sleepers, the North Western Railway authorities, after giving a year's practical trial to the new treatment specification worked out at Dehra Dun, omitted since 1930 the two restrictions on the sapwood content and distribution in *chir* and blue-pine sleepers.

In 1931, it was stated by the Railway Board and by the Joint-Secretary of the Education, Health and Lands Department of the Government of India that, as a result of applying the new treatment

specification, a sum of about 8 annas per sleeper was saved. Also, as a very much deeper penetration of the preservative fluid into the sleepers was obtained, a longer durability of life than that obtained previously could be confidently expected.

Very recently, the Indian Turpentine and Rosin Company, Ltd., who have been supplying for several years about a lakh or more *chir* sleepers annually for antiseptic treatment to the North Western Railway, wrote to the Forest Economist that in order to produce sleepers in agreement with the North Western Railway specification of 1928, " it would have been necessary to fell the same number of trees to produce a *third* less in outturn, and this scale of conversion would have been so wasteful as to make the supply at current prices impossible."

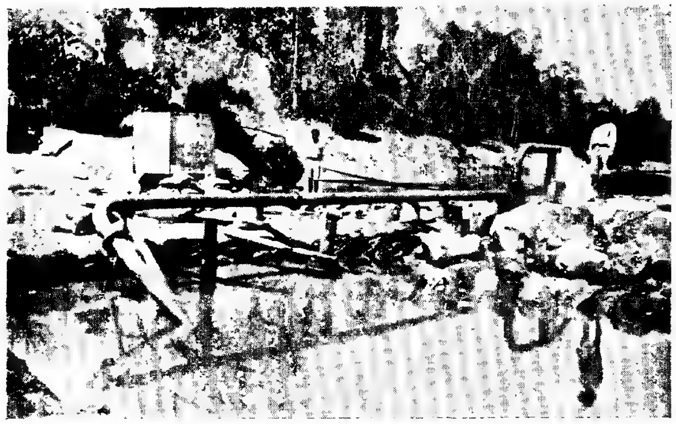
From this, two inferences can be drawn. Firstly, from the same volume of pine logs as those felled before for sleeper conversion, 50% more sleepers have been produced since 1930 when the writer's work was accepted by the North Western Railway, as indicated by the deletion of the two clauses regarding the restrictions on sapwood content and distribution. This naturally reduced the overhead and sawing charges on pine sleeper production besides reducing the waste of timber to a minimum. Secondly, by the reduction in waste during conversion, the price of *chir* sleepers has not only come down considerably, but it has been possible for the treated pine sleeper to remain in the market by being able to compete with the low-priced steel and cast-iron sleeper.

NEDUNGAYAM BRIDGE

The Nedungayam Bridge across the Karimpuzha River at Nedungayam, 7 miles from Nilambur, South Malabar, is one of the major engineering projects carried out by the Madras Forest Department with its own Forest Engineering Division.

Previously most of the timber from the Amarampalam Range was floated down the river to Beypore.

NEDUNGAYAM BRIDGE

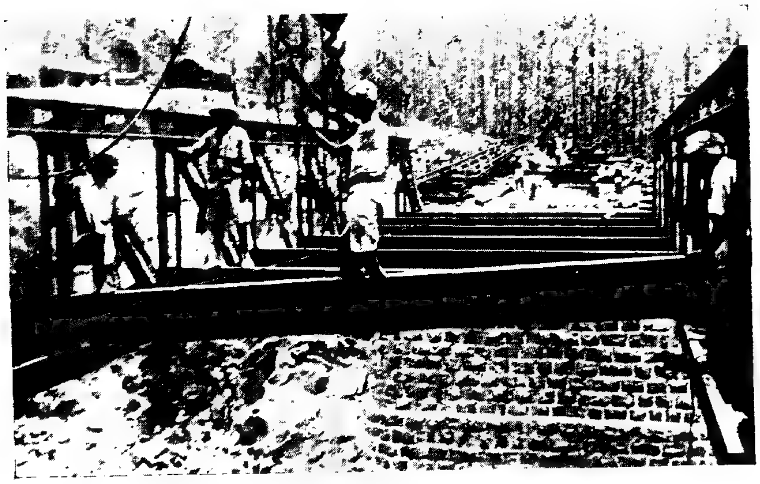


Pumping out a flooded coffer dam.

Inside of coffer dam after it has been pumped dry showing base of a pier.

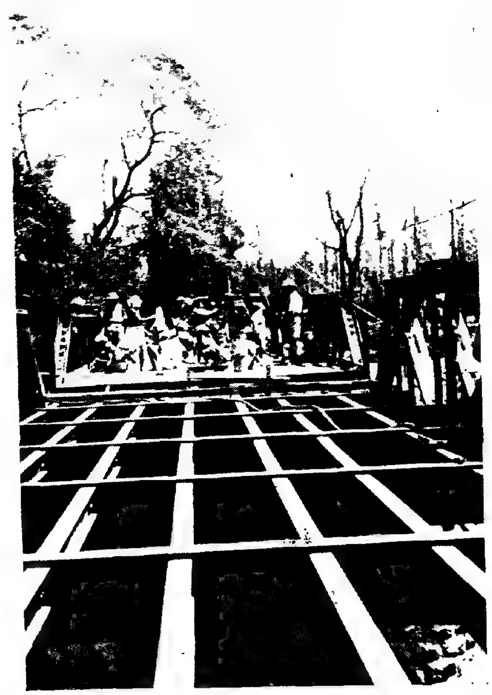
Girder being transported by means of the over-head cableway.

NEDUNGAYAM BRIDGE



Cross girders being placed in position.

Bridge under construction.



Preparing one span for concrete decking.

The Railway has been extended to Nilambur in recent years, however, and instead of having to depend on the West Coast market entirely and a short floating season it is now possible to take logs direct to Nilambur station by means of the bridge at any time during the year to supply other markets.

The bridge was officially opened in June 1933 by Mrs. Wimbush, wife of the Chief Conservator of Forests, Madras.

It consists of 4 latticed girder type spans of 62′-0″ each and has a clear roadway of 14′-6″ and is capable of taking a moving load of 15 tons. 35,000 cubic feet of masonry including concrete foundations was used in the construction of abutments and piers.

In order to get down to solid rock the excavations for the piers had to be carried down in some cases to a depth of 15′-0″ below the summer water level.

Sand-bag coffer dams only were used. They were kept clear of water by a 6″ E. Type Drysdale Centrifugal Pump with a capacity of 25,000 gallons per hour driven by an 8 h.p. Petter Oil Engine. This combination proved a most efficient unit.

Heavy rains in the Nilgiris which overlook Nedungayam were sometimes responsible for sudden rises in the river which either burst or swamped the coffer dams, and the Forest Engineering staff often had a scramble to rescue their equipment.

The 72 tons of steel in the bridge, *i.e.*, 18 tons for each span, was fabricated at site.

The Moplahs take readily to this work and there are some expert hand rivetters amongst them.

An overhead cableway was improvised for handling the steel work by stringing a fixed wire rope of $1\frac{1}{2}''$ diameter, with two travelling pulley blocks on it, between two trees at a sufficient height to clear the top of the centre pier with a five-ton load.

To each of the travelling pulley blocks was attached a five-ton Yale hoist to allow loads to be raised or lowered easily.

They could be used either singly or together and were hauled backwards and forwards along the fixed cable by means of an endless non-galvanised wire rope $\frac{1}{2}''$ in diameter.

This control rope was worked by an ordinary 5-ton capacity crab winch, well anchored.

The drum of the crab winch was increased to 12" diameter and the control rope passed round it twice.

As will be noticed from the photographs the bridge has a pretty setting.

The Karimpuzha is one of the few clear rivers left in Malabar and anyone who has visited Nedungayam will always remember this pleasant spot on account of the delightful bathing to be had there and possibly on account of the many big fish in the river that expert anglers have often found extraordinarily difficult to catch.

JUNGLE WILES

The Tale of a Horn.

The rhinoceros is one of the rarer animals of India and Burma that is seriously threatened with extermination. This is not the result of the value of his horn as a sporting trophy, though the possession of one is appreciated by sportsmen, but rather to the monetary value of the horn, carcase and blood in certain markets. It is computed that the body of a dead rhinoceros is worth as much as Rs. 2,000, the horn, if judicially sold, will fetch anything from Rs. 200 to 300 per pound of weight. It can, therefore, be easily imagined that the shooting of one of these animals is far too great a temptation to resist to any jungle man licensed by a too credulous District Magistrate to possess a gun for the alleged protection of his crops. An unfortunate animal with a price of this magnitude on his head has as much chance as an icicle in hell.

Superstition is largely to blame for this exaggerated value and has imbued the horn particularly with medicinal qualities that are supposed to be beneficial in cases of consumption, asthama, debility, etc.

Superstition is the brother of gullibility and this brings me to a tale of a simple, honest-to-goodness jungle man's guile.

NEDUNGAYAM BRIDGE.

Probably it was hunger that stirred the gray matter in the brain of Nga Paw. The bamboo had flowered and his small plot of hill rice, planted on a hill-side in a clearing in the forest, had been destroyed by an invasion of rats, who habitually swarm at these periodical flowerings of bamboo; they infest the flowered area to gather the harvest of seed, and in their stride do not disdain to take any rice that may be present in the vicinity. So, Nga Paw, who from the experience of generations had expended sufficient energy to plant just enough to carry him and his family through the succeeding year, found himself faced with the problem of finding food for three perfectly healthy stomachs. He gave only a fleeting thought to the fact that he could earn sufficient money to see him through by seeking employment in some relief works started by a benevolent Government for him and his fellow-sufferers, it was discarded as being much too arduous and slow.

He knew and loved the vast evergreen forests in the neighbourhood of his village, and to him the obvious thing to do was to look to the natural resources of the forests for help. They had often before provided a means when he was hard pressed. The theft and sale of a log or two from the Government Reserves, or a shot with a borrowed gun at a sambhur visiting a salt lick at dusk and the sale of the meat, had before now set him up financially for a time. But the idea that occupied his mind now filled him with visions of wealth and surpassed anything he had done hitherto in similar circumstances.

He conferred secretly with his croney, Nga Mya, and presently they departed into the forest together, from whence they returned after about a week in excellent spirits. The next day Nga Mya announced that he was going to visit his maternal uncle who lived in the more populous and richer agricultural district about four days' march over the hills.

Arriving at the dwelling of his uncle on the afternoon of the fourth day Nga Mya was hospitably welcomed. Over their evening meal, to satisfy the obvious curiosity of his people as to the reason of his visit, he told them in confidence that he had come on some business and had a small rhinoceros horn for sale. He asked to be

informed of any discreet purchasers. The name of a Chinaman known to be prudent and wealthy was furnished, and Nga Mya and his uncle arranged to visit him together next day. After thanking his host for his interest in the business Nga Mya lay down in a corner of the hut, stowed the horn away in his haversack and slept soundly. Next morning he awoke to find to his dismay that the horn was missing from his bag. He immediately roused his host and his wife and informed them of the loss. They showed signs of anger and surprise that a guest and a relation should have been robbed in their house; they were most indignant; they hoped that suspicion would not attach to them. They racked their brains to discover who in their small village would be most likely to commit such a deed; they sympathized very much with their nephew.

This was decidedly not one of those occasions when one fearlessly appeals to the law and the justice of one's fellow men. The possession of a rhinoceros horn is emphatically discouraged by Government, and heavy penalties are demanded from the law by the Forest Department for the joy of this possession. So, Nga Mya, his eyes dark with suspicion and some well chosen phrases on his lips, shook the dust of his uncle's hut off his feet to return with the news of the unfortunate result of his journey to Nga Paw, waiting hopefully across the hills.

Although the matter was kept as quiet as possible, nevertheless, a rumour spread that a valuable rhinoceros horn had been stolen from his nephew during his recent visit to Nga Hmaw's dwelling and was hidden in or near it. Suspicion naturally alighted on Nga Hmaw and as somebody has said "Little fleas have smaller fleas upon their backs to bite 'em, etc.," there were one or two get-rich-quick adventurers in the village ready, in turn, to relieve him of the coveted horn. One or other of these, Nga Hmaw soon discovered, persistently stalked him, wherever he went they were not far away, they stuck to him closer than a brother; he was annoyed at this unwelcome interest.

The rumour, travelling in ever-widening circles, eventually reached the local Forest Ranger. The Ranger reported confidentially and

spies, rewards and the usual machinery of detection was started. Nga Hmaw, who, of course, was not unaware of all this, found his annoyance giving place to anxiety. He seemed to see eyes peering at him from most unexpected places, the thing was getting on his nerves. However, he bided his time, and one night while a pwé—a dancing and singing party which no Burman can keep away from—was performing in the village he thought he had found the opportunity of ridding himself of the purloined property, the cause of all his anxiety. Departing stealthily he crept away and disinterred the horn from the foot of the coconut tree in his garden and made rapidly for a large village a couple of miles away, and in particular, for the house of the Chinaman, devoid of curiosity, prudent and wealthy, whom he had recommended for these qualities to his nephew.

Now, John Chinaman may, or may not, have heard the rumours that were afloat, but anyway, a matter of this kind provides an excellent opportunity of driving a hard bargain. On being shewn the horn he reflected on the genuineness of the article and offered Nga Hmaw exactly one-thirtieth of the price demanded, *viz.* ;—Rs. 150/-. This was indignantly refused by Nga Hmaw, and John refusing to raise his offer, he returned to his village. He had not anticipated any difficulty in disposing of what he was now beginning to think of as an encumberance and his failure to do so added to his anxiety.

The cumulation of unpleasant incidents attaching to the ill-gotten possession of the horn and his failure to dispose of it quickly and profitably were more than Nga Hmaw's nerves could bear. The announced arrival of the Ranger the next day to hold an inquiry, to which he had been summoned for examination, was the last straw, and the harrassed Nga Hmaw, eager to be rid of his incubus, decided to hand it over to the Ranger and bear the consequences. He was willing to forego any benefit he had hoped to derive for the comfort of an easy mind. In the meanwhile he must think of a plausible tale for the Ranger's ears.

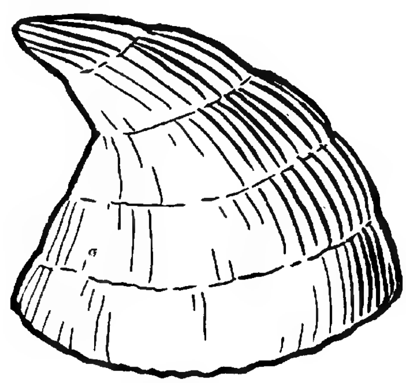
True to his determination the horn was duly handed over to the Ranger the next day with the story of its purchase from an unknown

man from across the hills and—his anxiety had not quite killed his greed—a hint that he might receive at least part of the reward offered for his public spiritedness in keeping the horn safely and delivering it up promptly, thus saving a lot of the official's valuable time.

"The said rhinoceros horn is forwarded herewith." So ended the Ranger's report. "File" scrawled in the margin and another "human document" has come to rest.

The accompanying article, the pawn of the simple, honest to-goodness, jungle man's ingenuity, guile and cupidity, is before me now, a dark brown, polished horn about six inches long tapering to a blunt point, growing out of a circular, convex base bearing squared markings. It is a very fair imitation of a small rhinoceros horn.

The convex circular base is the kneecap of a buffalo, the horn it supports is another piece of slightly curved bone. The whole has been carefully put together and shaped by covering with a kind of rough lacquer obtained from a tree found in the forest, and nicely finished off with a hatching to simulate the rough skin of the animal.



The "horn" rests on my desk and makes a handy paperweight and serves as a reminder, if one were needed, that the proverb about glitter and gold applies equally well to men and things, simple and sophisticated.

S. S. O.

LOVE'S LABOUR LOST

BY WAT. A. HOPE.

We're all trying hard to do taungya
We're planting every species that is known
But what's the use of trying, when the b—y things keep dying
And the ground is dry and hard as any bone
Oh, it ain't gonna rain no more, no more
It ain't gonna rain no more.
We do our very best
But we get a bit depressed
When it ain't gonna rain no more.
We sold great chunks of jungle for " hajamat "
We burnt them till the skies with smoke were blue
The Conservator he came, many letters to his name
And he told us just exactly what to do.
Oh, it ain't
It ain't.
We heartily agreed
And we set to work with speed
But it ain't gonna rain no more.
Then we sowed *sal* seed in trenches by the thousand
Planted *jamun* in a moist and mossy dell
We sowed *sissoo,* too, and *khair,* where the ground was slightly higher
Also teak, although we hate the stuff like H—l.
But, it ain't, etc.
It ain't, etc.
The Ranger shook his head
" It's no good, they'll all be dead
If it ain't gonna rain no more."
When a shower came, the little seeds responded
And poked their little heads up in a row
But the sun shines bright each day, and they're fading right away
So we sow, and so and so, and then resow !
Still, it ain't, etc.
It ain't, etc.
Now how the Holy Joe
Can the damn plantations grow
If it ain't gonna rain no more ?

THE GENUS PSILOTUM IN INDIA.

BY MUKAT BEHARI RAIZADA, M. SC.,
Forest Research Institute, Dehra Dun.

A search through the literature and works of reference available at the Forest Research Institute, Dehra Dun, shows that little has been written regarding the genus *Psilotum* in India. With the exception of a short but extremely interesting note by Prain published nearly half a century ago in the " Journal, Bombay Natural History Society," Vol. VIII (1894), pp. 428—430, the other references to this genus are more or less in the nature of incidental remarks. This note has, therefore, been drawn with the object of supplying further information to those who may be interested in the habit, habitat and distribution of this genus in British India.

The genus *Psilotum* (the word is from the Greek and refers to the nearly naked stems and branches) belongs to the family *Psilotaceae* and includes two species *P. triquetrum* Sw. and *P. complanatum* Sw. Hitherto only the former has been recorded from India but as it is not improbable that the second one occurs here as well it has been thought advisable to point out the characters by which the two species may be distinguished.

General characters of the Genus.

Terrestial or sometimes epiphytic. Rhizome (root-steck) short, creeping, branched ; true roots wanting. Stem erect or pendulous, simple below, repeatedly dichotomously branched above ; branches angled or flat. Leaves very minute, scale-like laxly disposed, trifarious or distichous. Sporangia (synangia) rigidly coriaceous, turbinate, umbilicate (hollowed) at the apex, 3-lobed, 3-celled, splitting vertically down the centre of each lobe, placed singly free in the axils of rudimentary leaves (bracts) all down the branches. Spores numerous, minute, oblong, somewhat curved, one-ribbed.

Classification of the Genus.

According to Prain *loc. cit.* seventeen different forms of *Psilotum* have been named and described ; these arrange themselves into two

groups of which *P. triquetrum* and *P. complanatum* may be taken to be typical, so the following diagnosis will assist in their determination:

Plant erect or suberect; branches triquetrous, many times dichotomously forked, ultimate branchlets three-cornered, at times almost round about 1/24″ in diameter; leaves and sporangia in 3-rows........ ....*Psilotum triquetrum.*

Plant pendulous; branches flattened, less frequently and more laxly branched, ultimate branchlets flat, with a distinct midrib 1/16″—1/12″ broad; leaves and sporangia arranged (distichously) in 2-rows..........*Psilotum complanatum.*

Distribution of the Genus.

Psilotum triquetrum is widely distributed in the tropical and subtropical moist regions of both hemispheres, extending as far north as Florida and Japan. It is found in South and Central America, Mexico, the West Indies, Florida, Africa (rare), Madagascar, Mauritius, India, Southern China, Indo-China, Japan, the Laccadives, Ceylon, the Andamans, the Malay Peninsula, the Philippines, Java, Australia (Queensland and N. S. Wales), Polynesia and New Zealand. The distribution of *P. complanatum* is equally wide, although it is the less common of the two except in Malaya. It has also, so far, not been collected from anywhere in British India. Both species, however, occur in the Mascarene Islands to the west and in Malaya and Polynesia to the east of India. There are, therefore, reasons to believe that both may be found in Peninsular India if carefully searched for. This hope, so far as the present record goes, has, however, not yet materialized.

The Indian distribution of *P. triquetrum* Sw., (*P. nudum* (L.) Griseb.), the only species of *Psilotum* so far recorded from India, as exemplified by specimens preserved in the herbaria of the Royal Botanic Garden, Calcutta, the Agricultural College, Coimbatore, (Madras Herb.), and the Forest Research Institute, Dehra Dun, which, for the sake of convenience and easy reference, have been arranged according to localities is as follows:—

(a) N. W. and Central India.

Wongtu, Upper Bashahr, Punjab, 4,500 feet, 22-5-1930, H. G. Champion, Dehra Dun Herb. No. 53807.

Kumaon, 2,000—3,000 feet, T. Thomson.

Nepal, Wallich.

Malaswamp, Pilibhit division, U. P., 3-3-31, A. E. Osmaston 1460.

Pachmaree about 3,000 feet, 1881, Mrs. C. Morris.

Below the Bee Falls, Pachmarhi, 18-2-1891, J. F. Duthie 10683.

Pachmarhi, Central Provinces, 3,600 feet, Oct. 1933, H. S. George, Dehra Dun Herb. No. 63918, 63919.

(b) Bengal, Assam and Burma.

Jalabari, Barisal, Bengal, March 1872, C. B. Clarke 16955 A.

Busrojogini, Dacca, 2nd April 1873, C. B. Clarke 20040 B.

Assam, Masters.

Sibsagar (Rangpore) Station, Feb. 1891, Gustav Mann.

Khasia Hills and Brahmaputra Plains. Herb. S. Kurz.

Assam, G. Watt 10416.

(c) South India.

Peninsula Indiæ orientalis Herb. Wight 3193.

Coonore Ghat, Nilgiri district, 5,000 feet. June 1883, J. S. Gamble 11755.

Periyar Falls, Balampatti Valley, Coimbatore dist., 1,800 feet, 23-5-1910, C. E. C. Fischer 1938.

The Kundah, Nilgiri, Feb. 1886, Madras Herb. No. 60191.

Iruttupallam, Coimbatore dist., Madras Herb. No. 60194.

Vellapatty, Coimbatore dist., 6th June 1914, Madras Herb. No. 60198.

Sengalteri, Tinnevelly dist., 18th Sept. 1914, Madras Herb. No. 60190 and 60202.

Mahedragiri Hills, Tinnevelly dist., 18th Sept. 1916, Madras Herb. No. 60201.

Minikoy, Laccadive Islands, 5th Dec. 1891, Alcock.

Central Province (C. P.), Ceylon, Thwaites 1420.

Ceylon, Walker 1420 in Herb. Ind. Or. Hook. fil. and Thom.

Central Province, Ceylon, M. N. Beckett 701.

The earliest valid name under International Rules of Botanical Nomenclature for the Indian species (of *Psilotum*) *P. triquetrum* Sw.,

should be *P. nudum* (Linn.) Griseb. as shown below :—

Psilotum nudum (L.) Griseb. Syst. Veg. Karaib. 130. 1857.

Lycopodium nudum Linn. Sp. Pl. 1100. 1753.

Psilotum triquetrum Sw. in Schrad. Journ. Bot. 1800²: 109. 1801.

Habit and Habitat.

The erect fastigiate habit of *P. triquetrum* and the hanging spreading habit of *P. complanatum* is alone sufficient to distinguish between the two species. *P. triquetrum* is generally 7—8 in. high but dwarf specimens measuring only 1·5—3 in. have been recorded while under favourable conditions it often attains a height of 2—2·5 feet.

The plant in its mature condition is quite devoid of roots, grows upon earth rich in humus and is evidently more or less saprophytic or it may be an epiphyte. That it prefers a situation where it can obtain plenty of decaying vegetable matter in which to bury its branched root-like rhizomes is no doubt true, for the specimens from ruins and rocks, are as a rule, dwarf and stunted, as compared with those growing in sink-holes or the hollows of trees. The following additional information taken from the labels attached to herbarium specimens will throw more light on the habitat of the plant (*P. triquetrum* Sw.) :—

"Growing in the hollow of a dead branch of a tree, Pilibhit," A. E. Osmaston ; "Grows attached to damp rock, Pachmarhi," H. S. George ; "Interior of Crater, Barren Island," Prain ; "Growing on stone near the crater of Gunong Boddas, Preanger, Java," H. O. Forbes ; "Growing on temples, Sibsagar, Assam," Masters ; "Growing on the trunk of tree beside the large stream Kwangtung, Hainan," Tsang and Fung.

In conclusion it is my pleasant duty to thank Mr. C. E. Parkinson, Forest Botanist, for his help and guidance and kindly going through the manuscript. I am also grateful to M. R. Ry. Rao Bahadur D. Ananda Rao Garu, I.A.S., Principal, Agricultural College, Coimbatore, and Mr. K. Biswas, Curator of the Herbarium, Royal Botanic Garden, Calcutta, for the loan of *Psilotum* specimens in their respective charge.

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THE WOODY PLANTS OF NATAL AND ZULULAND.

Being a Key for the identification of Woody Plants based on leaf characters.

BY J. S. HENKEL, D.SC., F.R.S.S.AF. Pp. 252.

This little book is meant to enable persons resident in and visitors to Natal and Zululand to identify the various indigenous shrubs and trees. It consists mainly of a key based on vegetative (chiefly leaf)

characters by means of which the reader with little or no knowledge of botany may determine the names of the woody species of the province. No difficulty should be experienced in following the key for the characters used are all clearly explained in a useful glossary with some illustrations. The main divisions of the key are given in a clear outline with steps that lead to the groups, twenty-nine in number, and these in turn are further subdivided or stepped and lead ultimately to the name of the plant which is followed by a useful description, chiefly of the vegetative characters, with which the reader may check up his plant. No floral characters are used except in the case of *Erica*, though fruit characters are frequently given in the descriptions; this seems a pity, for flowers are often very striking and a brief reference to them, without going into detail, would have been useful as a check up in naming the plants. *Erythrina caffra, Bolusanthus speciosus, Kigelia pinnata* and many others have such distinctive flowers that a few words about them in the descriptions would have been as useful as those that have been given regarding fruits, but this apparently has been carefully avoided. After the descriptions the occurrence of the species is mentioned. A useful bibliography and indexes to botanical terms and species and, very thoughtfully, a metric and inch scale for field use, is included. The book has been well got up and is evidently the work of one who thoroughly knows the plants in the field. It cannot but prove useful to those interested in naming up or studying the plants of the province.

C.E.P.

EXTRACTS.

THE GIRDLING OF FOREST TREES.

By E. J. Strugnell.

Girdling or ringing has been used since time immemorial as a means of killing trees which it is not desired to go to the trouble of felling, and in silvicultural operations in particular this method has various advantages as a means of eliminating competition from unwanted and unmarketable trees. In the first place the tree dies slowly and the lightening effect on the undergrowth is spread over a period of one to two years, which gives the regeneration below time to accustom itself to the increased light and heat, instead of the sudden exposure, with often disastrous consequences, due to felling. Secondly, the damage caused by the falling of the tree is minimized by girdling. The tree dies and the leaves fall, followed by the twigs and branches and finally the bole, and very much less damage to regeneration is caused by this piecemeal dissolution, than by felling the living tree. A further advantage is that death by girdling in the case of certain weed species such as *Macaranga* is not followed by profuse coppicing as happens when the tree is felled.

On account of these advantages, girdling has been used in this country for silvicultural operations on a large scale.* In practice it was found that by no means all trees died promptly when girdled, and observations were started to obtain precise data as to what proportion of trees could be expected to die from girdling, what period had to elapse before girdling became effective and whether some species were more resistant than others. To this end four plots containing 358 trees were laid out in the four districts of the western circle of Pahang. In forests as rich in tree species as those in Malaya, 358 trees were not enough to give sufficient data to determine the varying resistance of different species, and returns of trees which were found to be resistant to girdling were sent in from districts where silvicultural operations involving extensive girdling were being carried out.

The method of girdling has naturally a great influence on the results obtained. Mere removal of the bark without penetration of the wood is often followed by callus formation across the girdle and the recovery of the tree. Much deeper girdling is necessary for good results: girdles varying from ½" to 2" according to the size of the tree are used in Malaya. Too deep girdling is to be avoided, as the trees, especially if they are hollow, are very liable to be thrown by wind. In one of the Pahang experimental girdling plots no less than 48% were broken at the girdle by wind before the crown was dead, thus losing the most important advantages of girdling. The average percentage broken throughout the four plots was 24.

The trees in the plots were identified by herbarium material sent to the Forest Research Institute at Kepong, and girdling was done in the ordinary way, though more thoroughly than would be possible in normal silvicultural work, as the selection was confined to trees which could be girdled thoroughly, omitting those with awkward

* See " Elements of Malayan Silviculture," by D. H. Hodgson, *Malayan Forester*, Vol. I, p. 88.

buttresses and in contact with other trees, such as have to be dealt with in routine girdling operations. Inspections were made at intervals of two to three months over a period varying from 2 to 3 years, and the results from the 4 plots have been compiled and tabulated below:—

Condition.	Length of time under observation in years.							
	¼	½	¾	1	1¼	1½	1¾	2
Healthy	226	176	134	95	61	39	32	21
Dead	93	135	172	204	242	272	283	303
Percentage dead ..	26	38	48	57	70	79	80	85

Total number of trees 358.

Sickly trees intermediate between the healthy and dead classes have been omitted for the sake of clearness. Dead trees include those broken by wind at the girdle.

It will be noted that only 21 or 6% of the trees remained healthy at the end of 2 years, while of 180 trees on which observations were continued for 3 years, 4% remained healthy. These trees were, however, doomed, as the wound had in no case healed over, and rot and insect attack at the girdle were slowly completing what the attempt to interrupt the supplies by the girdle had not done.

As regards the dead trees, a quarter died in the first 3 months, the figures being swelled by a large proportion of breakages at the girdle. This rate of mortality did not continue, but a slower rate continued steady until 18 months, by which time 79% of the trees were dead, the rate of mortality then dropped and by the time 2 years had elapsed 85% mortality was reached. In the two plots in which observations were carried on for three years, the percentage dead at the end of this time was 92.

The result may be summarised therefore that girdling as practised in this country will give 75% success within 18 months, and two-thirds of the balance will be dead in 3 years.

The size of the trees has an influence on the speed at which the tree dies, small trees dying more quickly than large trees. At 9 months after girdling, when the tides of death were running strongly, an analysis of girths gave the following results:—

Percentage of trees dead 9 months after girdling.

Girth class, inches.	Total No. of trees.	Number dead.	Percentage.
12—24	14	8	43
24—36	144	46	32
36—48	99	32	32
48—60	54	12	22
60—72	26	3	12

Above 72″ girth there were too few trees to give reliable results. The number of trees given as dead do not include those broken at the girdle.

Size has no effect on the final result, it merely defers the death of the tree owing to the large food supplies available.

The many observations of details made during inspections of the plots are summarised below :—

In the first place the flowering and fruiting which was expected following girdling did not take place. A very common development was a growth of callus on the upper edge of the girdle. In one species (*Coccoceras muticum*) callus also formed on the lower edge and on the stump after the tree broke at the girdle.

Roots were formed at the girdle by species of the following genera :—

Ficus, *Elaeocarpus*, *Homalium*, and *Eugenia*, whilst *Elaeocarpus* developed in addition epicormic shoots above the girdle. The development of epicormic shoots below the girdle was a common feature, but many died with the death of the tree after a short and vigorous life.

Many trees were attacked by borers at the girdle, and termites also did a great deal of damage. Any tree which does not succumb to the effect of the girdle will in all probability fall a victim to insect attack on the wound.

Apart from 3 routine inspections of the Pahang plots, the writer has merely compiled the results, the work in connection with them having been carried out by the District Forest Officers concerned.

Poison girdling.—In poison girdling the girdle is treated with a poisonous solution, usually of an arsenical nature. As a result of an article by C. W. Allan in the *Indian Forester* (1918, p. 23) experiments with poison girdling were instituted in this country and the results were given by A. E. Sanger-Davies in a letter to the same periodical (1919, p. 547). In it he noted that trees which were resistant to the ordinary form of girdling soon succumbed to the poison. The experiments did not lead to any development, mainly on account of the quantity of poison required coupled with the high cost of the proprietary preparation employed, which precluded its use in large scale operations under Malayan conditions.

In 1932 interest was stimulated by an article in the American *Journal of Forestry* (Poisoning undesirable trees, by A. L. MacKinney and C. F. Korstian, Vol. XXX, No. 2, p. 169) describing a system of "frill" girdling combined with the use of sodium arsenite as a poison. Experiments were carried out in the Sungei Buloh forest reserve by A. B. Walton with complete success, no girdled tree surviving. The "frill" consists of a ring of downwardly directed single axe cuts which run into each other forming a groove or trough round the tree into which the poison is poured from an oil can. The original solution used in America contained half a pound of arsenious oxide and one of lye per gallon of poison, but in Malaya a much stronger solution containing 6¼ lbs. of sodium arsenite per gallon, which is roughly equivalent to 5 lbs. of arsenious oxide, was used, so that the Malayan solution was 10 times stronger in poisonous principle. The effect has been so deadly that weaker solutions are now being tested.

It is noticeable that insect and fungus attack soon develops near the girdle, and that the poison does not seem to deter the insects; probably because it is so quickly dispersed. It spreads from the cuts very rapidly in a vertical direction and can be traced as it progresses up the tree by the discolouration of the layers near the cambium. It also spreads in a horizontal direction but only within narrow limits, and experiments have been laid down to determine how far this can be relied upon to kill a tree in the case of incomplete girdles, which are all that can be carried out in the case of trees of very irregular shape, such as many species of *ara* (*Ficus* spp.).

During the course of silvicultural operations in the plantations at the Forest Research Institute, Kepong, 860 trees of well over 100 species were girdled and poisoned, and were observed twice a month for the first 24 weeks, after which the period was lengthened to one month. The results of the inspections, which are still being carried out, are given in the table below :—

Period in weeks.	*Number of trees dead.*	*Percentage dead.*
4	284	33
6	377	44
8	471	55
10	516	60
12	549	64
14	591	69
16	630	73
18	648	75
20	..	..
22	696	81
24	709	82
28	726	84

It will be noted that there has been a progressive falling off in the rate of mortality after 55% of the trees had died by the end of 8 weeks, and it is probable that at least 18 months will have elapsed before all are dead. It has been observed that, in the case of all trees of the 16% now remaining alive, the bark and cambium is dead all round the tree in the neighbourhood of the girdle, though the crown still appears healthy, so that death can only be a matter of time.

It is interesting to compare the rate of mortality of these poisoned trees with that of the unpoisoned girdling plots in Pahang. Results have been obtained in 6 months by the use of poison that took two years without this aid. It will be necessary to adjust silvicultural methods to the use of poison, taking into consideration this increased rate of mortality. This question is dealt with by J. N. Oliphant in another article in this issue.

The question that immediately suggests itself to the practical forester is whether costs can be reduced by the use of poison and whether figures comparable with the costs of the present system of girdling without poison (R. I. F.) are available (see *Malayan Forester*, Vol. I, p. 88). No figures have yet been worked out for a system designed specially for use with poison. In 1933 C. L. Durant undertook a carefully controlled experiment in Bikam reserve in which 41 acres were treated as in ordinary R. I. F., except that frill girdling and poison was used instead of an

unpoisoned deep girdle, the costs were compared with those of a similar 89 acre control block treated in the ordinary way. His costs worked out at \$5·10 per acre for the work with poison, against \$4·42 for work without poison. The reasons for this rather unexpected result were three. In the first place the silvicultural system was not adapted for use with poison: with the system described by J. N. Oliphant it is expected that considerably less girdling will be necessary, as the desired light-conditions are to be secured by removal in the first instance of the more light-obstructing trees, which are not necessarily nor even usually the largest. With R. I. F., moreover, the majority of the expense is in connection with palm and undergrowth cutting, on which of course the use of poison has no effect. Even so a labour saving of 16% was obtained. Secondly, the labour costs were extremely low (35 cents per man per day) owing to the slump, as against a normal rate of 60 cents, so that the cost of the poison ranked high in comparison. Thirdly, the cost of the proprietary poison used worked out at \$3·30 per gallon, as against 60 cents a gallon for the solution of sodium arsenite solution at present in use.

The new system designed for use with poison girdling is expected to be materially cheaper. V. Bain, who has conducted the girdling experiments at Kepong, calculates the cost of poison girdling, with sodium arsenite (80/82%) at \$10·71 (£1-5-0) per cwt., equivalent to 60 cents per gallon of poison ready for use, at 1·33 cents per foot of girdle. Similar figures on the same costing basis are now required for ordinary routine girdling.

As regards species resistant to poison girdling, the same difficulty arises as before, *i.e.*, so many species come into consideration that adequate numbers of each for observation are not always available.

Reference may be made here to unpublished experiments on poisoning trees conducted by R. C. Barnard and C. O. Flemmich. In these, a 20% solution of "Atlas" tree poison was used in an apparatus consisting of a container connected by tube with a hole 5″—8″ deep bored in the tree. Results were unsatisfactory, as, though the tree died in some cases, a frequent result was the death of one or more branches, the remainder of the crown being unaffected. The investigators remarked that the results bore out the fact that transfusion of liquid in a tree is mainly in a vertical direction and that horizontal transfusion occurs only within narrow limits. The method may be dismissed as unreliable, slow and cumbersome.

Sodium arsenite is, of course, a powerful poison, a salt spoon containing considerably more than a fatal dose and due precautions must be taken in its use. Instructions are being drafted and will be published in due course.

The results of girdling may be summarised as follows:—Ordinary girdling to a depth varying from ½″ to 2″ with the size of the tree gives a mortality of 75% in 18 months and two-thirds of the balance in 3 years. Much more expeditious and certain results may be obtained by frill girdling with the use of sodium arsenite solution as a poison, the mortality reaching 83% in six months.

(*Malayan Forester*, October 1934).

PLANTS IN RELATION TO LIGHT AND TEMPERATURE.

BY V. H. BLACKMAN, F.R.S.

EFFECTS OF TEMPERATURE.

[Read July 19, 1933; SIR ARTHUR HILL, D.Sc., F.R.S., in the Chair.]

Temperature is, of course, one of the main factors which control the distribution of plants on the earth's surface. In this respect it ranks below water-supply but is more important than light, of which the intensity is very commonly in excess. Everyone is familiar with the fact that there is commonly a more or less restricted range of temperature within which plants can live. Above a certain level plants are killed by excess of heat, but this is much higher than that at which satisfactory growth is achieved. At low temperatures there is no growth or germination, and at still lower levels the plant is killed. Certain plants such as bacteria are very resistant to the action of low temperatures and are not killed even if exposed to liquid air. This resistance is probably related to their very small size. Even ordinary plants are not frozen at the ordinary freezing point (0°C. =32°F.). The substances (sugars, salts, etc.) dissolved in the cell-sap lower its freezing point below that of water, and the small size of the chambers (cells, wood vessels, etc.) in which the sap is contained is also inimical to the formation of ice. A number of plants are able to carry on various life processes and to grow at temperatures about freezing point. It must, however, be borne in mind that the respiration of the plant produces heat as well as carbon dioxide, so that if heat loss is not very rapid the plant may be at a temperature slightly higher than that of its surroundings.

When considering the effect of temperature upon a plant or upon plant processes, it is usual to speak of a minimum, optimum, and maximum. The optimum is the temperature at which the plant is supposed to grow best, and the others are assumed to represent the lowest and the highest temperatures at which the plant will grow at all. These standards of temperature have, however, no very exact purport. In considering the effect of temperature the time of exposure must be regarded. A high or low temperature which has little effect at first may after a time prove injurious. A curve showing graphically the rate of growth of seedlings of maize at different temperatures is given in fig. 110 (not printed). It will be seen that the optimum there shown is about 32°C. (87·5°F.) and the minimum and maximum at about 4° (39°F.) and 47° (116·5°F.) The results only apply for the particular period during which the rate of growth was observed. This relationship between temperature and time is well brought out in the table given below, in which the optimum temperature for the rate of growth of the roots of cress seedlings is given.

Roots of Garden Cress.

Optimum temperature and time of exposure.

3·5 hours	.. ..	30° C.	(86° F.)
7 ,,	.. ..	29° C.	(84° F.)
14 ,,	.. ..	27·2° C.	(81° F.)

If the period of exposure was three and a half hours at the different temperatures, the optimum was found to be at 30° C. With longer periods the optimum is less, and at 14 hours is only 27·2° C. This brings out clearly the fact that these so-called optimum temperatures may really be injurious, but the harmful effect naturally takes time to show itself.

The optimum temperature is incapable of exact definition, since it depends not only on time of exposure but also on the action of other factors—the inter-relationship of factors already referred to. The inter-relationship of temperature and light is shown in the table below, which gives the relative rate of growth (based on the time taken to double the frond number) of Duckweed (*Lemna*) exposed to different temperatures and different light intensities. It is seen that with increase in the light intensity to which the plants are exposed the most favourable temperatures shifts to a higher level.

Duckweed (Lemna).
Effect of varying Light and Temperature.
Relative rate of growth in arbitrary units.

	350	750	1000	1400 foot-candles.
15° C.	1·0	1·5	1·4	1·3
22·5°C.	2·9	3·1	3·3	2·6
25° C.	3·0	3·8	4·0	4·2
30° C.	3·0	4·1	4·4	4·0

Such effects are still more marked with young tomato plants in glass houses; as the light intensity increases with the advancing season the most suitable temperature also advances. One may say generally that if other conditions are favourable a rise of temperature of 10° C. (18° F.) will increase the rate of growth and the rate of many other plant processes by two to three times.

The effects of temperature on plants are so numerous that only a few special cases can be considered. Reference may first be made to the remarkable effect of exposure to different temperatures on the later flowering and fruiting of certain plants. This effect was first brought to light by experiments with certain agricultural crops. It is well known that if *winter* cereals are sown in spring they usually fail to " head " that season and give no crop, thus differing markedly from *spring* varieties. It was shown by GASSNER about sixteen years ago that this was largely an effect of temperature, for if the winter varieties are exposed during germination to temperatures a little above freezing point they can be planted quite late without undue delay in flowering. The low temperature during the early stages of growth—at the time when the rudiments of the flower have not even been laid down at the stem apex—has in some way affected the plant so that normal flowering and fruiting are achieved much earlier. It is a kind of *predetermination*, the earlier exposure to a low temperature determining the later flowering and fruiting, though we do not know how this is effected.

An example of this effect is shown in some experiments with winter rye carried out at the Imperial College. The only difference between the plants seen in the

photograph (not printed) is that those on the left were exposed during germination to a temperature of 1° C., those on the right to 18° C. After this the conditions were the same for both sets of plants, yet those which were kept cool during the early stages of growth failed to develop a flowering axis and to bear ears. The cereals are long-day plants, so these pot-cultures were exposed to long days. Exposure to short days prevented flowering even in plants exposed to 1° C.

That the effect of the low temperature is to induce "earliness" is shown by the data given in the following table, where the plants have been exposed during germination to temperatures of 15—20° C. and of 2—3° C. and sown at different dates.

Winter Cereals and Temperature of Germination.

Sowing Date.	*Date of Ear Appearance.*		*Days Early.*
	15—20° C.	2—3° C.	
	Wheat.		
December 18	June 16	June 9	7
March 3	August 13	July 23	21
April 15	September 18	August 10	39
April 25	no earing	August 11	(infinite)
	Rye.		
January 9	June 2	June 2	0
February 6	June 9	June 9	0
April 15	August 4	June 18	47

As the date of sowing gets later the gain in earliness with "cool" germination gets longer and longer. With winter wheat sown on April 25 there is no "earing" with germination at the higher temperature, so the gain is infinitely large.

This predetermination by temperature, though discovered in 1917, remained until comparatively recently of purely physiological interest. During the last few years, however, botanists in Russia have taken up the study of physiological predetermination and have shown not only that it can be achieved by light as well as by temperature, but also that it can be of practical value in agriculture and horticulture. The work in this field has been published mostly in the Russian language, but a most valuable summary in English has recently appeared (R. O. WHYTE and P. S. HUDSON, Vernalization : Imperial Bureau of Genetics, Aberystwyth, 1933).

The work has been mostly carried out at the Odessa Plant Breeding Station and a process has been elaborated which is called Jarovizatzia in Russian and may be anglicized as vernalization. The essential discovery is that the exposure to low temperature may be given at a stage as early as that of the swollen but ungerminated grain. Furthermore, the effect persists even if the grain be dried after treatment and planted later. Vernalization is applied on the large scale in the granary in the following way. If wheat is to be treated the grain is spread in heaps and water supplied to an amount sufficient to allow of the water-content reaching 50 per cent. of the dry matter ; to secure a rapid absorption of water the temperature should be 10—12° C. The grain is then spread out in layers 8—10 inches deep and kept

preferably at 15° C. After a short period all the embryos will have begun to grow and in some grains the young roots will have pierced the coat of the grain. The process of vernalization should then be applied by opening at night the doors and windows of the granary so that the temperature is reduced to 3° C. It is kept at this temperature for 10—15 days and is then ready for sowing. If kept for later sowing it must be dried.

This process of vernalization can of course be applied to autumn cereals in agreement with GASSNER's pioneer work, but even with spring wheats it markedly accelerates ear-formation and so secures an earlier harvest. The results with two pure line wheats are shown in the following table.

Pure Line Wheats sown April 11.

	Date of Ear Formation.	*Days Early.*
A. vernalized	June 5	25
A. untreated	July 1	..
B. vernalized	June 12	18
B. untreated	July 1	..

Such acceleration of ripening is of great importance in wheat grown in the semi-arid steppes of the Ukraine, since the high summer temperature damages all but early ripening crops. Thus the unvernalized crops, being later, were caught by the droughts of summer and gave very low yields—in the case of A only one-twenty-fourth and in the case of B only one-fourteenth of the treated.

Vernalization by Light Treatment. The Russian workers have made a most interesting extension of the work in which predetermination is brought about by heat. The cereals of the temperate zone, such as wheat, barley, oats and rye, are long-day plants and can be grown under continuous light. Such tropical and sub-tropical plants as sorghum, Sudan grass, millet, maize and Soya bean, require a high temperature and a short daily period of illumination. If exposed to continuous illumination or to long days they may fail to flower, and this is a hindrance to the extension of their cultivation to more northern latitudes. It has been found, however, that this difficulty can be overcome, for by suitable treatment the plant can be brought into a physiological condition in which the reproductive phase occurs later irrespective of exposure to short days, in fact it will appear even in continuous light. This physiological condition is brought about by exposure of the swollen seed to a period of darkness at a fairly *high* temperature. The period of darkness accelerates the onset of the reproductive phase so that during its later growth the plant is largely independent of photoperiodic (*i.e.*, length of day) conditions. In the case of millet the partly moistened seed is kept in the dark for 5 days at a temperature of 25—30° C., sorghum requires 8—10 days at the same temperature, while maize requires 10—18 days at 20—30° C.

Vernalization of the Potato.—The object of vernalization is to induce an earlier appearance of the reproductive phase. The process might seem of little use in the case of a crop grown not for seed but for some vegetative part. It has been known for some time that length of day affects tuber-formation, and it is claimed that in the potato the production of tubers can be accelerated if the tubers before planting are

suspended in the greenhouse and receive normal illumination during the day and electric light of high intensity during the night; the temperature should be 15—20° C. With such treatment the buds grow rapidly, but remain quite short owing to the dryness of the air and to the illumination.

Social Flowering of Plants.—There are a number of cases known, especially in tropical orchids, where in a particular region all the plants flower suddenly on the same day. *Dendrobium crumenatum* is an example, and has been closely studied in Java. In this plant the flower-buds develop slowly during a long period till they reach an advanced stage, when further development stops. The buds usually remain in the dormant condition for a considerable period and then, suddenly, in the buds of all the plants in that locality development begins again, and the bud matures and the flower unfolds all in a few days. It seemed certain that the sudden burst into activity must be due to some change in the environment of the plants acting as a "trigger mechanism." In agreement with this view it was shown, first by an English botanist, that the flowering of these orchids occurs 9 or 10 days after a shower of rain, some other species, however, taking 30 days. It was also shown that the same phenomenon is to be observed in species of Coffea and also in *Murraya exotica* among the Rutaceæ. Attempts, however, to break the dormancy of the buds by artificial watering were without success. It appeared, then, that the simultaneous quickening of the buds which is responsible for social flowering is some concomitant of heavy rainfall, not the actual wetting. This was confirmed by the fact that orchids protected from wetting in a glasshouse flowered at the same time as their fellows outside. It was noticed that a heavy tropical shower often results in a marked lowering of temperature: in Java the fall may be 6 9° C. (11 16° F.). Accordingly COSTERS (Ann. Jard. bot. Buitenzorg, 35, 1926) tried the effect of sudden cooling combined with moisture by placing in water at 20° C. for 2–20 hours the aerial parts of the plants bearing the dormant flower buds. The experiment was entirely successful. Fig. 113 (*not printed*) shows shoots of the orchid *Dendrobium crumenatum* after placing in water at 18-20° C. for one and a half hours. On the left is a shoot 1 day after treatment; the other shoots represent stages 3, 4, 5, 7 and 8 days after treatment, culminating on the extreme right with fully opened flowers, 9 days after treatment. Another orchid, *Thrixspermum arachnites*, showed a similar response. Fig. 114 (*not printed*) shows shoots (reading from left to right) 0 to 8 days after treatment. If the shoots were cooled *slowly* from 30° to 20° C. there was no effect. The effect could be achieved without wetting, for the plants will respond to sudden cooling of the air. Coffee flowers within a week of rain following a period of drought. Here also the buds after reaching a certain stage of development pass into a dormant state from which they are roused by a change in the environment; either wetting or cooling or increased moisture in the soil will act. *Murraya exotica* flowers about 14 days after shower, but the effect has not been further analysed.

Temperature and Periodic Changes.—The effect of temperature on the unfolding of buds and the development of flowers—apart from the special cases mentioned above—is, of course, a commonplace in horticulture. In the flowering of perennial plants, such as Tulip, Hyacinth, Lilac, Azalea, Apples, etc., we are dealing with the

development of a bud which was formed many months earlier, usually in the previous year. Our knowledge of the effect of temperature on the flowering of such plants is incomplete and one-sided if we are acquainted only with its effect on the unfolding of the bud and the elongation of the flower stalk. For a full picture of the response of the flower to temperature we require a knowledge of its effect on the initiation of the flower bud and the development of its parts before opening. The rapid unfolding of the bud may be the more striking phenomenon, but in physiological importance the period of the constitution and differentiation of the floral organs must take first place.

Until comparatively recently there was little information available as to the effect of temperature on flower-initiation. About 1920, however, BLAAUW at Wageningen in Holland began elaborate investigations of the effect of temperature on various stages of the development of the Hyacinth and the Darwin Tulip. The effect of eleven different temperatures (1·5–35° C.) was studied in relation to the three cardinal stages of these plants, (*i*) leaf formation, (*ii*) formation of the flower, and (*iii*) the elongation of the floral axis. It was soon evident how different is the temperature response of the last two processes, for in the Darwin Tulip the optimum for flower-building is about 17–20° C., while that for elongation of the flower stalk is at first about 9° C., gradually rising to 20° C. In the Hyacinth the corresponding stages show optima at 25° C. and 13° C.

Using the information of the response of these plants to temperature, Tulips and Hyacinths and plants may be induced to complete their whole life-cycle in 8 to 9 months. It seems, however, that this period cannot be shortened further, however the external conditions may be manipulated. In these investigations a number of interesting differences between the two plants were brought to light. One of them has been stated; another was the fact that for the Tulip the lower temperature inhibiting growth is 1° C., while for the Hyacinth it is 5° C. Furthermore, in the Hyacinth the growing point will react immediately to a temperature suitable for flower formation, while in the Tulip flower formation cannot be inaugurated until all the foliage leaves have been laid down. We see how the march of the plant's development is controlled by the cycle of temperature changes.

Of recent years forcing methods have been applied also to Daffodils at the Laboratory for Bulb Investigation, Lisse, Holland. In a Daffodil bulb grown in the open in Holland, the laying down of the floral parts begins early in May, while the normal lifting time is two to two and a half months later. By the middle of June the parts of the flower are complete except for the trumpet. The initiation and development of the Daffodil flower is thus much earlier than in the Tulip, so it is impossible to control the early stages of the floral development by storage conditions. If flower formation is to be hastened it must be done through modification of the conditions of growth. One method is to plant the bulbs in greenhouses or in situations where the warmth of the climate causes an earlier blooming. In the latter case, however, the high temperature at lifting time common in such regions is inimical to early forcing later. Bulbs grown in such regions, if the capacity for early forcing is to be retained, must be stored in cool conditions after lifting. By suitable

manipulation of temperature Daffodils may be made to bloom before Christmas. This is brought about by storage at 48° F. from July to November, or storage at 62·5° F. for two weeks and then storage at 48° F. ; after boxing they are kept at 48° F. and then brought into the forcing house in late November or early December. The variety Lady Moore began to bloom after 16 days forcing and Early Surprise after 14 days (see J. J. BEYER en E. VAN SLOGTEREN, Vroegbrcee van Narcissen: Laboratorium voor Bloem bollenonderzoeh te Lisse, No. 45, 1932 ; also E. VAN SLOGTEREN, The Early Forcing of Daffodils : Year-book, Royal Horticultural Society, London, 1933, pp. 41 49). These reactions of the Tulip, Hyacinth, and Daffodil are remarkable examples of the control which temperature is able to exert on different stages of the life-cycle of the plant.

Only a very few of the multifarious aspects of the regulation which temperature exerts on the plant's activities have been considered. I should like, however, to end on the note of *interaction of factors, i.e.*, of the interrelationship of the effects of environmental conditions. Light, temperature, air-humidity, soil moisture—all play an important part in the control of the life of the plant, but alteration of one of these will almost certainly affect the action of the others. On this account it has been well said that wise gardeners do not attach too much importance to the natural conditions in which wild plants are found growing. It is usually impossible to reproduce artificially *all* the conditions of the natural environment and the alteration of one of them may necessitate the modification of one or more of the others, and so a wide departure from the natural environment.

(*Journal of the Royal Horticultural Society*, July 1934.)

*POSSIBILITIES OF IMPROVING PULPING CHARACTERISTICS OF PULPWOODS BY CONTROLLED HYBRIDISATION OF FOREST TREES.

BY ERNST J. SCHREINER, RESEARCH FORESTER, OXFORD PAPER CO., RUMFORD, MAINE.

Abstract.—The improvement of forest trees by breeding or by pure line or mass selection can be expected to prove profitable not only to the wood-producer but also to the industry which utilises the wood. Breeding and selection directed towards the best corelation of what may conveniently be termed "forest requirements" of the producer and the use requirements of the industry, is practically an unexplored field and the first strides in this direction may therefore be expected to result in valuable developments.

The new hybrid poplars produced by the breeding project of the Oxford Paper Company are decidedly more valuable than the native poplars: They grow more rapidly, are more easily propagated, and in numerous cases are more resistant to diseases. On the basis of investigations on young trees, many of the hybrids can be expected to produce wood with a longer average fibre length and somewhat higher density than the wood of the native poplar (aspen) commonly used in Maine for soda pulp. It is certain that the best of these new hybrids are desirable and valuable for any forestation plantings in which poplars are to be employed.

* Presented at the annual meeting of the Technical Association of the Pulp and Paper Industry, New York, N. Y., Feby. 18 to 21, 1935.

The results obtained in the poplar breeding project fully support the view that hybridisation and selective breeding of forest trees will give results comparable to those realised in the development of the older crop plants.

The chief source of the fibrous raw materials used in the production of pulp and paper are forest trees. Practically all of this raw material is obtained from forest stands which have developed naturally without artificial aid of any kind. There is still a great quantity of wood in our natural forests especially in the South and West, and to a greater extent than is often appreciated, even in New England. The question which is of most importance to the individual pulp and paper company is the species composition of the natural forest and the proximity of this natural wood to its own mill.

In general two courses are open for the utilisation of existing forest stands by an established mill; those species which are suited to the manufacturing process can be used, or the manufacturing process can be changed to suit the species which are most abundant and available at reasonable cost. In the early years of the industry the first procedure was the general rule. Due to the abundance of wood it was possible to use only those species and even those sizes of trees which were most desirable for production purposes. In late years the rapid disappearance of the most desirable species has made it necessary to use increasingly larger quantities of the wood of species which were formerly considered less desirable. Balsam fir is probably a typical example of such a species. More recently manufacturing processes have been changed and new processes are being devised to utilise species which could not be used previously. The work now under way on southern pine is an example of this change in utilisation.

Numerous paper companies have adopted more or less empirical systems of forest management to insure a future supply of suitable timber within easy reach of their own mills. In many cases natural reforestation can be assured by relatively simple and comparatively inexpensive methods, such as protection of young growth during the logging operation, adequate provision for seed trees on the cut-over area, girdling of weed trees and protection against fire and live-stock. With such forest improvement methods the forester is limited to the species which occur on the area as seed trees, or as advance reproduction.

Artificial reforestation by planting or seeding is being carried on by many paper companies to restock areas where natural regeneration is uncertain, or where the natural reproduction consists predominantly of undesirable species. Such reforestation permits of a wide choice of growing stock, but native species and varieties have usually been used for forest planting and only a few desirable species have been introduced from other countries. Although some emphasis is placed on the selection of seed from individual trees of outstanding qualities, and considerable effort is made to collect seed for use in a particular region from an approximately similar environment, few attempts have been made to apply systematic breeding and selection methods to the improvement of forest trees.

The possibilities of improvement by controlled breeding and selection have long been generally recognised in all phases of agriculture and animal husbandry. The

application of such methods for the improvement of forest trees was stressed by Henry as early as 1910. Within the last 20 years forest tree-breeding has been discussed to some extent in widely scattered publications, but relatively little actual breeding work has been undertaken, and from a practical standpoint this is still a virgin field.

Unfortunately the improvement of forest trees has always appeared to be a long-time proposition, and in cases where the fixation of hybrid characteristics can only be obtained through repeated seed selection this is especially true. A short cut to this ultimate end is possible through the vegetative propagation of desirable hybrids in groups of trees which can be reproduced from cuttings, root-suckers, etc. For example, one individual poplar or willow tree can eventually be multiplied into innumerable trees by annually cutting up the young stems into ten-inch lengths and planting these pieces in the ground. All the trees which are derived from one individual in this manner are members of a "clone", and except for the relatively infrequent somatic mutations they all have the identical hereditary make-up and the same qualities as the original tree. Any desirable characteristics of a hybrid poplar can therefore be maintained by means of vegetative propagation.

Many of our most important forest trees cannot be economically propagated by vegetative means. Propagation by grafting is possible but at the present time it is too expensive for forest planting stock. The possibility of developing a satisfactory method for the vegetative propagation of tree species which are ordinarily propagated only by seed should be considered. Where means of vegetative propagation are lacking improvement of forest planting stock is possible by utilising the frequent uniformity and "hybrid vigor" of first generation hybrids (*i.e.*, by always growing hybrid seed) or by selection of natural races or strains of native species. Pure-line selection would be highly desirable but mass selection will be more practical with most forest species.

The improvement of trees may be considered from the viewpoint of the producer (in this case the forester) who needs a tree which will yield the highest return in the shortest period of time, and from the viewpoint of the consumer (in this case the mill man) who is looking for a tree which will supply the fibrous raw material best suited to the production of a particular product. (In most cases a paper company is both producer and consumer but for the purposes of clarity this distinction will be used in the discussion). The requirements of the producer and consumer are not always identical and the breeder must recognise, breed for, and select those individuals which combine to the best advantage the qualities desired by both producer and consumer. For example, in the breeding of trees for pulpwood the forester desires a fast-growing tree because a short cutting cycle results in a higher return on the investment. The mill man is interested in a tree with wood of high density because of the direct corelation between the density of the wood and the yield of pulp per cord. In some instances, these two qualities will be negatively correlated (*i.e.*, fast growth will produce light wood and slow growth will produce heavy wood) and the tree breeder must than select individuals which combine these two qualities to the best advantage.

Improvement of forest trees from the viewpoint of the Forester.—The characteristics or qualities which the forester is primarily interested in developing through breeding and selection of forest trees may be quite clearly defined. In general most importance will be placed upon hardiness in the region where the trees are to be grown, rapidity of growth, low susceptibility to disease and insects, and low cost of propagation and planting. These characteristics are essential for profitable reforestation.

Improvement of forest trees from the viewpoint of the Mill Man.—The manufacturer of paper and pulp is primarily interested in the characteristics or qualities of the wood of forest trees. His most direct interest in tree-breeding would be in the possibilities for improvements in the quality of the fibrous raw material (wood) which will be reflected in the quality or cost of his finished product. Each mill has its own particular requirements with regard to wood quality so that definite desirable characteristics can hardly be set down. Furthermore many qualities and properties of wood and their effect upon the finished product have not yet been adequately defined.

Physical characteristics of the wood and fibre.—Wood of high density, durability in storage, with a minimum of knots, and in some conifers a minimum pitch content are qualities of the wood which are generally recognised as desirable. There is also considerable evidence that the penetration of cooking liquors into wood is related to the structure and arrangement of the cells in the wood as well as to the size, shape, and moisture content of the chips.

Fibre length is related to certain properties of the finished paper such as strength, formation, surface and finish. The influence of other physical characteristics of the wood fibres upon the properties of the finished paper is not thoroughly understood. The fineness of the fibre, *i.e.*, the relative diameter per unit length, must be reflected in some characteristic of the sheet. It seems probable that fibres of different species vary structurally (possibly in the arrangement of their fibrillar constituents) but the effect of such differences upon the finished sheet is still a matter for speculation.

Chemical characteristics of the wood and fibres.—Aside from the physical differences between various woods there are variations in chemical composition which are certainly reflected in the manufacturing processes and in the finished product. The wood of different tree species varies in the percentage of cellulose, lignin and other chemical constituents. Furthermore there seems to be some variation either in the nature of cellulose and lignin in different woods, or more likely in the quantity, composition or bonding of the materials closely associated with the cellulose and lignin. Possibly, the percentage of lignin which is very intimately associated with the cellulose varies in different woods. The effect of these chemical characteristics of the raw material on the manufacturing process and on the finished product is generally admitted but not definitely understood. The yield available within the range of commercial bleachability and the maximum brightness attainable with any combination of commercial pulping and bleaching processes are apparently functions of the chemical composition of the fibrous raw materials. The permanence of the finished product may also be partially related to the chemical characteristics of the fibres.

Response of the pulp to beating and the colour, strength, brittleness, softness, bulk, density, opacity, absorbency, and surface of the paper, although very definitely

influenced by the manufacturing processes, are in the last analysis apparently limited by inherent characteristics or qualities of the fibrous raw materials. These qualities or characteristics of the wood may be physical, structural or chemical in nature, or they may be combination effects.

Fundamental investigations will eventually clear up the relationship between the properties of the finished product and the properties of the fibrous raw materials but for the purposes of the tree-breeder it is sufficient that these variations exist between the wood of different tree-species, and to a much more limited extent between the wood of trees of the same species. Variation is the "stock in trade" of the breeder because it is through variation and well directed selection that valuable improvements are obtained.

In discussing variation within a species, it is necessary to note that the properties of trees of the same species often vary with latitude, altitude, site, quality and other environmental conditions. In some species such variations may indicate geographic races and may actually be inherent characteristics. Environmental conditions do have a marked effect on the characteristics and qualities of many plants. Complete control of these variations are beyond the limits of breeding work but such developmental variations should be considered in local plantings. It is necessary to choose the proper site for each new tree type, but the requirements probably fall within broad limits in any one locality and should not be difficult to recognise.

POPULAR BREEDING PROJECT OF THE OXFORD PAPER COMPANY.

In 1924 the Oxford Paper Company in co-operation with the New York Botanical Garden started a project for the improvement of poplars by hybridisation. This work was carried out under the direct supervision of Dr. A. B. Stout of the New York Botanical Garden. Since that time the Eddy Tree Breeding Institute has been established in California for the improvement of conifers. Hartley has discussed forest genetics with particular reference to disease resistance. Koehler and Paul of the Forest Products Laboratory have called attention to the relation of genetical factors to the quality of wood produced in forest trees but state that nothing elaborate along this line is being attempted beyond "experiments on grafting scions or buds of figured walnut, maple, etc., on normal root stocks to see if trees with figured wood can be produced in that way.. .. .."

The improvement of forest trees has also received considerable attention in Europe. An experiment station for the study and the culture of the poplars has been established in Italy. Dr. V. Wettestein has hybridised a number of poplars in Germany and has published a report of his work and brief descriptions of the young hybrids. A project for the selection and establishment of pure lines has been initiated by Nicolai in Danzig and this work is apparently well under way.

Poplar was chosen for the breeding work undertaken by the Oxford Paper Company because of its importance as a raw material for the production of soda pulp and because of the ability of poplars to reproduce vegetatively from cuttings. Mature trees of many species, varieties and hybrids of this group were available for the work of breeding at the New York Botanical Garden and at Highland Park, Rochester,

N. Y., and trees of the native Necklace Poplar (*P. balsamifera* var. *virginiana*) were available on the grounds of the New York State Experiment Station at Geneva, N. Y.

The Poplar Breeding Project from the Viewpoint of the Forester.—The breeding project has been highly successful and the general results have been reported in several publications. A total of over 13,000 new hybrids have been produced from about 100 different cross combinations between different types of poplars. At the present time 69 individual hybrids have been selected for use in reforestation. Many of these appear to be much better than existing species, varieties or hybrids, in rapidity of growth, resistance to disease, low cost of propagation, hardiness, and habit of growth. The remaining hybrids are growing in forest plantations and are now 6 or 7 years old. It will soon be possible to cut some of these trees, and to select for desirable properties from the standpoint of pulp and paper production.

From the viewpoint of the forester the breeding project has resulted in the creation of numerous poplar hybrids which appear to be very promising for reforestation planting. Some of the best hybrids growing in forest plantations in Oxford County, Maine, have reached a diameter of 6 to 7·5 inches at breast height (4½ feet above the ground) and a total height of 30 to 35 feet in 8 years. The best of the previously existing poplar hybrids growing in comparable forest plantations of the same age are only 3 to 4 inches in diameter and 20 to 25 feet in height. Many of the new hybrids have so far been highly immune to various poplar diseases and all of the selected hybrids have been entirely hardy under climatic conditions in Maine, in spite of the fact that one or the other of the parents of some of these hybrids are highly susceptible to frost injury. All of the selected hybrids root very readily from cuttings and in some instances the rooting ability of the hybrids is far better than that of the parent stock. The selection studies have now reached the point where it is possible to indicate the most likely hybrids for economically successful reforestation.

The Poplar Breeding Project from the Viewpoint of the Mill Man.—Selection from the standpoint of the mill man for the improvement of pulping qualities must be based upon studies of the wood, and the lack of fundamental data on the correlation between wood properties and pulp properties eliminates any method other than pulping trials for the detection of such improvements. Pulping tests on a laboratory scale will soon be possible on many of the hybrids in the older plantations. Up to the present time fibre length and density are the only properties of the wood which have been investigated.

Fibre length in poplar (as in all tree species which have been investigated) increases with age up to a maximum which is rather well defined for each species, and then remains fairly constant. The average fibre length in one-year-old wood should therefore be indicative of the probable average fibre length in the mature tree. The average fibre length in one-year-old wood of several of the new hybrids is between 0·8 and 0·85 mm., compared to an average length of 0·53—0·57 mm. in one-year-old wood of the trembling aspen (*Populus tremuloides*) which is extensively used for the production of soda pulp. These hybrids should therefore supply wood with longer fibre than is available in the wood of the native aspen.

Preliminary studies indicate that the wood of the new, faster growing hybrids is somewhat denser than aspen wood grown in western Maine. Microscopic examination of the wood indicates that this may be due primarily to the proportionately larger vessel volume (*i.e.*, greater percentage of air spaces per unit volume) in the wood of the slower growing aspen. Paul reports similar correlations between density and vessel volume in the wood of fast-growing and slow-growing trees of other diffuse porous, hardwood species. Other factors, such as average fibre diameter, thickness of the fibre wall, percentage of ray or parenchyma tissue per unit volume of wood, may also contribute to the differences in the wood density of the poplars under discussion.

(*Paper Trade Journal*, Feby. 21, 1935).

INDIAN FORESTER

NOVEMBER, 1935

THE DISTRIBUTION OF INDIAN CONIFERS IN CHINA

By C. G. Trevor

A very interesting paper on the distribution of conifers in China was contributed to the Fifth Pacific Science Congress by Dr. Hsen-Hsu-Hu, Director of the Fan Memorial Institute of Biology, Peiping. Of the Podocarpaceae, there are six species of Podocarpus. *P. neriifolius*, which is found in the Himalayas, Burma and the Andamans, is widely distributed in Kiangsu, Kiangsi, Chekiang, Szechuan, Yunnan, Kwangtung and Kwangsi. The Indian Taxus is also found in Szechuan and Yunnan. Dr. Hsen-Hsu-Hu calls the Indian yew *Taxus wallichiana* Znee, but Pilger in the *Pflanzenneich* and Dallimore and Jackson in the *Handbook of Coniferae* retain the time-honoured name *T. baccata* Linn., which we prefer.

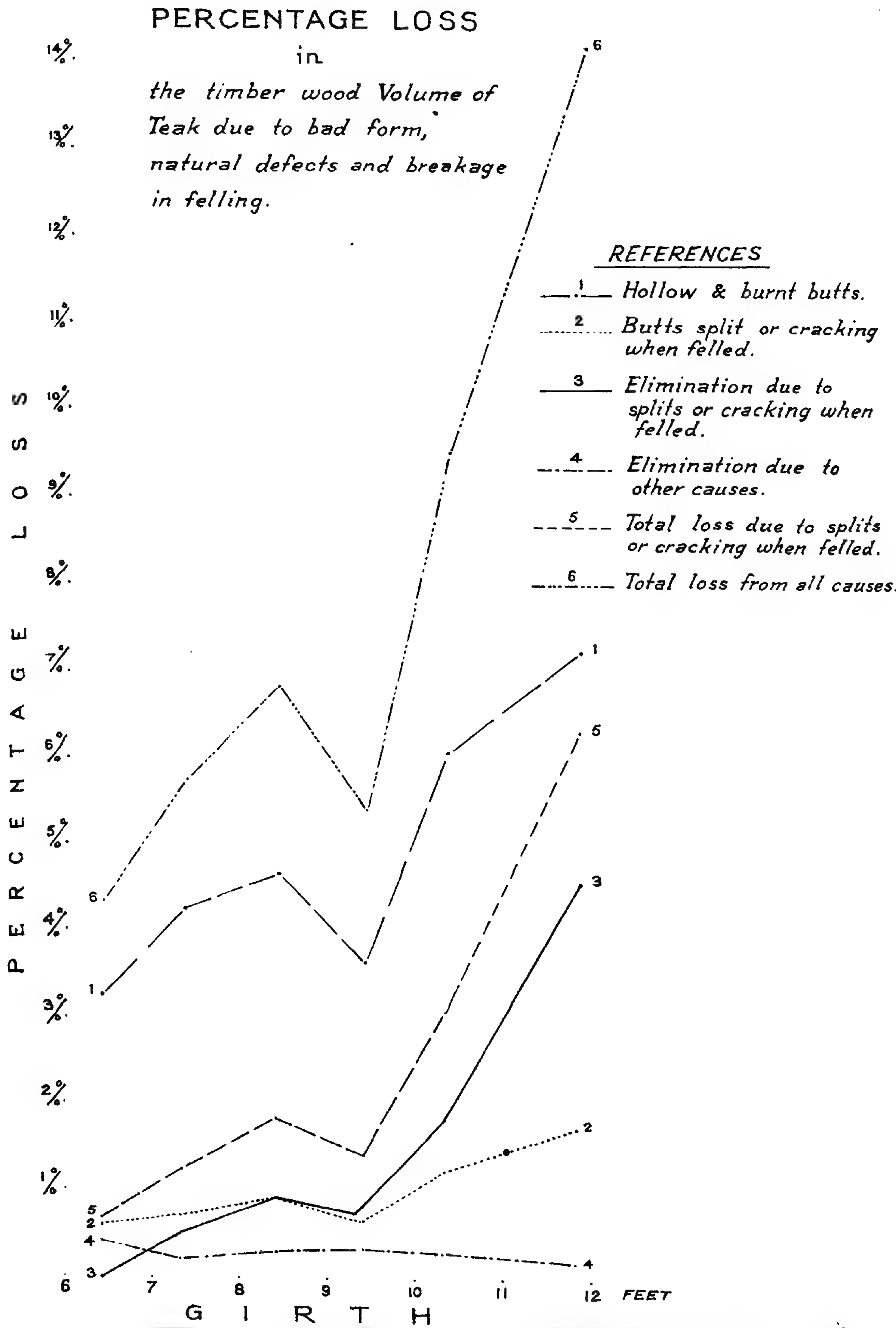
Cephalotaxus mannii Hook.f., a small tree of the Khasia hills, is also found in south-western Yunnan.

Dr. Hsen-Hsu-Hu says that *Abies webbiana* is found in the Tsang-Po-gorge of eastern Tibet at altitudes of 3,000 to 3,400 metres. Surely this must be the East Himalayan silver fir *Abies densa* Griff. which appears confined to the eastern Himalaya and extends perhaps into Nepal but not further westwards, certainly not as far as Afghanistan as given by Dr. Hu. The true *A. webbiana* is more likely to be the Kumaon and West Himalayan high level silver fir for which the oldest name would appear to be *A. spectabilis* Spach.

A. delavayi, reported by Dr. Bor from the Aka hills of Assam, is the common silver fir of western Szechuan and Yunnan, reaching an altitude of 12,000 feet in the Techienlu and Tali ranges. The silver fir of Siberia and the Altai mountains is *A. sibirica* and the spruce *Picea obovata*. *Picea schrenkiana* is widely distributed in Central Asia and forms large forests at elevations of 4,500 to 10,000 feet in Russian Turkestan, but no mention is made of the Indian spruce *P. morinda*,

which must be very nearly related to the spruce of Turkestan. Of the genus Larix, *L. sibirica* is found in the Altai mountains of Mongolia as well as throughout the whole of Siberia. *L. potanini* is the common larch of western Szechuan where it is found from an altitude of 7,500 feet to the limit of arboreal vegetation. *L. griffithii*, the Indian larch, is only reported from the Tsang-po and Chumbi valleys of eastern Tibet. The genus Pinus is well represented in China, *P. excelsa* has lately been discovered in north western Yunnan at elevations of 5,000 to 7,500 feet so that the distribution of this tree extends throughout the length of the Himalayas from Afghanistan to China. No mention is made of *P. longifolia*, its place being apparently taken by *P. yunnanensis*. *Cryptomeria japonica*, extensively cultivated in Darjeeling, forms vast and magnificent forests in the wilderness of southern Chekiang and Fukien where it is found mixed with *Torreya grandis*, *Cupressus funebris* and *Cunninghamia lanceolata*. No mention is made of *Cupressus cashmeriana* about which there has lately been correspondence in the pages of the *Indian Forester*. *Tsuga brunoniana* is reported from the Tsang-po-gorge and is stated to be the famous "*Cha*" tree of Tibet which yields excellent timber; several other species of Tsuga are also found as well as two species of Pseudotsuga: *P. sinensis*, a large tree up to 120 feet growing at altitudes of 3,000 to 7,500 feet in Yunnan, and *P. wilsoniana*, a tree up to 80 feet growing at 10,000 feet in parts of western Yunnan and Formosa. Mention must also be made of the uncommon genus Taiwania (p. 3279) interesting on account of its peculiar distribution. It is a Formosan conifer and was originally thought to be endemic to that island but it has recently been discovered on the Salween-Irrawaddy watershed in western Yunnan and in the hills of the Myitkyina district of Upper Burma (see *Indian Forester* 1933, p. 691).

Altogether there are recorded in China 23 genera and 105 species of Conifers. Although the Chinese flora contains a considerable percentage of Japanese elements, the absence of certain Japanese genera is noteworthy. These genera are Sciadopitys, Thujopsis and Chamaecyparis. In comparison with Europe the coniferous genera common to both regions are Taxus, Abies, Picea, Larix, Pinus,


PERCENTAGE LOSS
in
the timber wood Volume of Teak due to bad form, natural defects and breakage in felling.
PERCENTAGE LOSS
14%.
13%.
12%.
11%.
10%.
9%.
8%.
7%.
6%.
5%.
4%.
3%.
2%.
1%.
6
7
8
9
10
11
12
FEET
GIRTH
REFERENCES
1 Hollow & burnt butts.
2 Butts split or cracking when felled.
3 Elimination due to splits or cracking when felled.
4 Elimination due to other causes.
5 Total loss due to splits or cracking when felled.
6 Total loss from all causes.

Cupressus and Juniperus while such genera as Cedrus, Tetraclinis and Arceuthos are not recorded in China.

SOME NOTES ON THE PERCENTAGE LOSS IN THE TIMBER VOLUME OF TEAK, DUE TO BAD FORM, NATURAL DEFECTS, AND BREAKAGE IN FELLING

BY R HOBBINS, A.C.F., PYINMANA DIVISION

The data from which the attached graphs were compiled were obtained from the study of the work of a timber firm over an area of approximately two and a half square miles. Before dealing with the actual figures it may be of interest to give a short description of the forest and country worked over.

The area has an annual rainfall of 60 to 80 inches and is drained by one main stream. The slopes are moderate. As may be expected the ground is cut up by innumerable small feeders of the main stream, in which the mother rock is exposed. The forest is rather open, teak (*Tectona grandis*) and *taukkyan* (*Terminalia tomentosa*) being the main species in the canopy, with *tinwa* (*Cephalostachyum pergracile*) and *wabo* (*Dendrocalamus brandisii*) in the understorey. During the hot weather the forest becomes very dry and is burnt over every year.

In this area selection girdling of teak was carried out, and the 1355 trees from which these figures have been obtained were girdled.

The percentage losses shown in the graphs are based on the gross volume of timber which, on its size alone, would have been marketable if some deformity or accident had not excluded a percentage of it from that category. To illustrate this, an example may be quoted.—

A tree is felled and is found to have a large basal hollow, which necessitates butting and the top is cracked in felling. Supposing the total volume of "sizable" timber to be 180 c.ft., the butt 36 c.ft. and the top 18 c.ft., then the percentage loss due to the basal hollow is 20% and the split top 10%, thus giving a total loss of 30% in the timber wood volume.

In connection with this it may be mentioned that under the rules under which teak is extracted in Burma the firms are required to take out all reasonably straight and sound logs if they contain more than 20 c.ft. of timber.

Originally an average figure for the percentage loss of all the trees on the area was desired, but as the study progressed it became apparent that there was quite a considerable variation in loss associated with different girths. Therefore the trees were divided up into girth classes, taking the girth as measured at the time of girdling, and the following table shows the number of trees and their average girth for each girth class and the average volume per tree :—

Girth class.	No. of trees.	Average girth.	Average $\frac{1}{4}$ g. volume cubic feet.
5′—6′-11″ ..	253	6′-5″	66
7′—7′-11″ ..	372	7′-4½″	95
8′—8′-11″ ..	327	8′-5″	115
9′—9′-11″ ..	208	9′-5″	154
10′—10′-11″ ..	121	10′-4″	186
11′ and over ..	74	11′-10″	249

Six graphs have been prepared to show the following :—

1. Percentage loss of timber by butting, due to hollows and burning.

2. Percentage loss of timber by butting due to splits or cracking, when felled.

3. Percentage loss of timber in eliminations, due to splits or cracking, when felled.

4. Percentage loss in eliminations due to other causes, such as bear-bites, top-hollows, etc.

5. Total percentage loss of timber, due to splits or cracking, when felled.

6. Total percentage loss of timber, due to all causes.

Before dealing with each graph separately there are one or two points which must be mentioned as they may be deemed to affect the accuracy of the figures. In all the girth classes there were a certain number of butts which were both hollow and cracked; in order to save confusion this total has been divided equally between the two classifications of butts. With the exception of one butt of 37·4 c.ft. necessitated by very heavy fluting, all butts have been taken into account in these calculations, as they are due either to hollows or splitting. Furthermore, excluding the 5′—6′-11″ girth class, every class has one or more trees completely split in felling. The volume figures for these trees have been included in the figures for eliminations due to splits or cracking when felled; these will be mentioned again when dealing with this graph.

In the following an attempt has been made to examine any salient features in the graphs; tabulated statements of the actual figures and volumes, as totals for each girth class dealt with, have been added.

1. Percentage loss of timber by butting, due to hollows and burning :—

Girth class.	Volume of butts due to hollows and burning.	Volume of butts due to hollows and cracking.	Gross volume of girth class.	Percentage loss.
5′—6′-11″ ..	513·5	49·1	16,571·6	3·25%
7′—7′-11″ ..	1,369·8	273·3	35,328·7	4·26%
8′—8′-11″ ..	1,593·9	346·0	37,704·1	4·68%
9′—9′-11″ ..	1,018·4	234·1	31,843·8	3·63%
10′—10′-11″ ..	1,191·2	490·0	22,538·6	6·11%
11′ and over ..	1,259·0	90·6	18,474·0	7·60%

Since damage by fire frequently results from exposed basal hollows, the volume of butting necessitated by burning alone cannot be distinguished in this graph. It may, however, be argued that the annual ground fire is a predisposing factor for basal hollows, but with this we are not concerned.

The main feature of this graph is that the decrease in the percentage loss for the 9′—9′-11″ girth class is very much greater than it is for any of the other graphs. Apart from this drop there is a steady and uniform increase in the percentage of timber lost.

2. Percentage loss of timber due to splits or cracking, when felled:—

Girth class.		Volume of butts due to splitting	Volume of butts due to hollows and cracking.	Gross volume of girth class.	Percentage loss.
5′—6′ 11″	..	73·3	49·1	16,571·6	0·59%
7′—7′-11″	..	116·6	273·3	35,328·7	0·72%
8′—8′-11″	..	175·5	346·0	37,704·1	0·92%
9′—9′-11″	..	101·3	234·1	31,843·8	0·69%
10′—10′-11″	..	42·8	490·0	22,528·6	1·27%
11′ and over	..	280·8	90·6	18,474·0	1·76%

It will be noted that in four girth classes the volume of butts due to hollows and splits collectively is greater than that due to splitting alone. As the former is divided equally between butts due solely to hollows and those due to splitting, it may be argued that the figures used for this graph are extremely inaccurate and misleading. On the other hand, it may be said, that unless a tree has a fairly large basal hollow to start with it would not split when felled, and such a hollow would in all probability necessitate butting on its own account. At the same time it must be remembered that the split may mean that

the log has to be butted two or three feet higher up. It, therefore, seems fairly equitable that this volume should be divided equally.

The uniform increase, apart from the 9′—9′-11″ girth class, is even more accentuated in this graph.

3. Percentage loss in eliminations, due to splits or cracking, when felled :—

Girth class.		Volume of eliminations due to cracking.	No. and volume of trees wholly split in felling.		Gross volume of girth class.	Percentage loss.
5′—6′-11″	..	12·0	..		16,571·6	0·07%
7′—7′-11″	..	91·4	1	97·7	35,328·7	0·54%
8′—8′-11″	..	222·6	1	119·4	37,704·1	0·91%
9′—9′-11″	..	87·8	1	152·4	31,843·8	0·75%
10′—10′-11″	..	49·3	2	372·4	22,588·6	1·87%
11′ and over	..	131·4	3	719·7	18,474·0	4·61%

With reference to this graph, it is possible that the percentage loss figures may again be considered inaccurate and misleading. In defence one must, of necessity, take into consideration trees completely shattered in felling, and it makes no difference whether such trees are included here or in the previous graph for butts.

4. Percentage loss in eliminations due to other causes, such as bear-bites, top-hollows, etc. :—

Girth class.		Volume of eliminations due to natural causes.	Gross volume of girth class	Percentage loss.
5′—6′-11″	..	70·2	16,571·6	0·42%
7′—7′-11″	..	71·7	35,328·7	0·20%
8′—8′-11″	..	111·6	37,704·1	0·29%
9′—9′-11″	..	104·1	31,843·8	0·33%
10′—10′-11″	..	63·4	22,538·6	0·28%
11′ and over	..	36·0	18,474·0	0·19%

The comparatively large percentage in the 5′—6′-11″ girth class may be put down to the fact that these trees were considered unsound or deteriorating at the time of girdling and therefore a larger percentage may be expected.

5. Total percentage loss of timber due to splits or cracking, when felled.

This graph was obtained by plotting the figures resulting from the addition of the totals of 2 and 3, and as such requires no comment.

6. Total percentage loss of timber due to all defects. :—

Girth class.		Total volume of all defects.	Gross volume of girth class.	Percentage loss.
5′—6′-11″	..	718·1	16,571·6	4·33%
7′—7′-11″	..	2,040·5	35,328·7	5·72%
8′—8′-11″	..	2,569·0	37,704·1	6·80%
9′—9′-11″	..	1,735·4	31,843·8	5·40%
10′—10′-11″	..	2,209·1	22,538·6	9·53%
11′ and over	..	2,616·9	18,474·0	14·16%
		Average percentage loss..		7·32%

Considering the large volume of timber dealt with it does not seem possible to maintain that the figures for defects, considered as a whole, can be inaccurate. Therefore it would appear, that timber losses for trees over 7 feet in girth, reach their minima in the 9′—9′-11″ girth class.

THE OCCURRENCE OF COLLAPSE IN CERTAIN INDIAN WOODS DURING DRYING, AND A STUDY OF THE METHODS OF ITS REMOVAL

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1. *Introduction.*

Some woods are liable to excessive and irregular shrinkage during drying, which gives a badly distorted appearance to the cross section of the piece of wood so affected. It is generally found that the wood of certain growth rings, or of part of a growth ring sinks in, giving rise to parallel longitudinal depressions on a radial sawn face, more or less similar to that of a wash-board. This defect is known as collapse. The end-sections of some of the collapsed boards of toon (*Cedrela toona*) are illustrated in Plate 46.

Collapse is said to be a serious defect in some of the commercially important woods of Australia, such as mountain ash (*Eucalyptus regnans*) and red ash (*Eucalyptus gigantea*). In the United States, it occurs chiefly on blue gum (*Eucalyptus globulus*), southern swamp oaks (*Quercus* spp.) and the heavier wood of red gum (*Liquidambar styraciflua*). Among the English timbers, some of the home-grown elms show a tendency towards this defect. Our experience with the air and kiln drying of a large number of commercially important woods of this country has been that with the exception of toon (*Cedrela toona*), ***chilauni*** (*Schima wallichii*) and oaks (*Quercus* spp.) there are very few Indian woods which are prone to this defect to an appreciable degree, unless the conditions of drying are made very drastic, when even a radial sawn plank of teak (*Tectona grandis*) may show considerable damage due to collapse. The following species in addition to the three already mentioned have been found to be

affected by this defect during drying :—

(1) *Machilus* spp.

(2) *Acrocarpus fraxinifolius.*

(3) *Amoora wallichii.*

(4) *Vateria indica.*

Although chiefly occurring in hardwoods, collapse is known to affect certain American softwoods, such as the heavy butt logs of western red cedar (*Thuja plicata*), and of redwood (*Sequoia sempervirens*), in which case it is a source of considerable loss and trouble. None of the Indian softwoods has been so far known to suffer from this defect.

2. *Incidence of collapse in toon.*

Four healthy and mature trees of toon, growing on a piece of cultivated land near Jhajra (about 11 miles west of Dehra Dun on the Chakrata road) were selected for an experiment on the shrinkage, swelling and hygroscopicity of the wood. The logs were cross-cut into 6 ft. long bolts, which were converted into one inch thick planks and $2\frac{1}{2} \times 2\frac{1}{2}$ inches scantlings. The converted material from each bolt was divided into two approximately equal parts, one for air seasoning and the other for kiln drying. The kiln drying was carried out in an external blower kiln, a different schedule being employed for material from different trees. The results of this test with regard to the incidence of collapse are shown in Table I. It will be seen that material from tree No. 1 collapsed more badly both during air and kiln drying than that from any of the other three trees. Our extensive observations with this wood have shown that the incidence of collapse varies considerably in different trees, even when they come from the same locality. In a consignment of 20 logs of toon received from Bengal for kiln drying experiments, material from only two logs showed any tendency to collapse. From outward appearance, these two logs were quite similar to the rest of the material and there was no indication whatsoever to show that the wood would collapse during seasoning. The locality of growth appears to have, therefore, no effect with regard to the tendency of wood to collapse.

TABLE I

Incidence of collapse in material obtained from 4 trees of toon (Cedrela toona)

Tree No.		No. of bolt from the butt end.	KILN DRYING. Total number of radial planks.	Badly collapsed.	Slightly collapsed.	AIR SEASONING. Total number of radial planks.	Badly collapsed.	Slightly collapsed.
1	..	1	7	6	1	7	3	3
,,	..	2	5	4	1	5	2	..
,,	..	3	5	4	..	5	1	..
,,	..	4	2	..	..	3	..	..
,,	..	5	1	1	..	1	..	..
Total for tree No. 1		..	20	15	2	21	6	3
2	..	1	3	1	2	4	..	..
,,	..	2	4	..	4	2	..	..
,,	..	3	2	..	1	2	..	..
,,	..	4	2	1	1	1	..	..
,,	..	5	2	1	1	3	..	..
Total for tree No. 2		..	13	3	9	12	..	..
3	..	1	6	2	..	4	..	1
,,	..	2	3	..	..	2	..	..
,,	..	3	3	..	..	3	..	..
,,	..	4	3	..	..	2	..	..
,,	..	5	4	1	..	3	..	..
Total for tree No. 3		..	19	3	..	14	..	1
4	..	1	6	2	1	5	..	..
,,	..	2	3	2	1	3	..	..
,,	..	3	7	..	3	5	..	..
,,	..	4	4	..	..	3	..	..
,,	..	5	..	..	..	..	..	..
,,	..	6	2	..	..	1	..	..
Total for tree No. 4		..	22	4	5	17	..	..

With regard to position in the tree, results in Table I show that material from the butt portion is more susceptible to collapse than that from the middle and top of a tree. It has also been observed that the youngest heartwood, *i.e.*, the portion occurring next to the sapwood zone has a greater tendency to collapse than the older wood near the heart-centre. In the case of Australian woods it has been reported that the material from top logs is more liable to collapse than from the butt logs, and in this respect toon differs from the Australian Eucalyptus and resembles American red gum, western red cedar and redwood.

Although toon is liable to collapse both during air and kiln drying, yet the extent of collapse during kiln drying is much greater than that during air seasoning. Some of the kiln dried planks of toon were found to collapse so badly that they were practically useless for any kind of work. No such bad collapse was noticed on any of the air seasoned planks. This is evidently due to the effect of high humidity and high temperatures employed in kiln drying, which cause a reduction in the strength of wood, and thus enables it to yield easily to any stresses that may develop during the process of drying. Under these conditions, those portions of a plank which have an inherent tendency to collapse can shrink to the fullest extent.

The material from various trees was kiln dried at different conditions of temperature and humidity, but it is not possible to derive any conclusions as to the effect of severity of drying schedules on the extent of collapse in dried wood.

During air seasoning it has been observed that more collapse occurs if green material is sawn and stacked for seasoning in the rainy season, when the atmospheric humidity is high, than in the dry weather. High humidity conditions during early stages of drying appear to increase damage due to this defect, and should, therefore, be avoided. During the dry weather, the surface layers dry more rapidly, attaining a low moisture content in a short time, which hardens the surface layers, making them stronger and more resistant to stresses that develop during the drying process.

The dimensions of a piece, length, breadth and thickness, do not modify appreciably the tendency of a specimen to collapse. It has been noticed that the end-sections of planks, about one inch thick along the grain, suffered almost to the same extent as the rest of the planks from which they were cut. Even small shrinkage specimens and thin veneers show evidence of collapse, when the wood is liable to this defect.

The first signs of collapse are noticed when the moisture content of the wood is about 50% to 60%. From that stage, the severity of collapse increases as the drying proceeds, and most of the collapse occurs before the fibre saturation point is reached. If a piece of wood is air seasoned down to about 25% to 30% moisture content, under not too humid atmospheric conditions, and the drying finished off in a kiln, most of the damage due to collapse can be avoided.

3. *Removal of collapse.*

For the conditioning of collapsed material, a process was discovered by Mr. Grant of Victoria (Australia) some 12 years ago, which has been tried in Australia and in England and has been found to give good results with certain timbers. The material to be conditioned is first dried down to about 10% to 12% moisture content and is then exposed to the action of steam at about 100° C. in a closed chamber for a period depending upon the thickness of the stock and the severity of collapse. Unless the collapse is excessive, this treatment enables the pieces to regain their original regular shape. The additional advantages are that (*i*) there is a definite gain in size, (*ii*) cupped and twisted pieces are somewhat straightened, (*iii*) the hygroscopicity is slightly reduced and (*iv*) the wood improves in its working qualities.

The process of conditioning collapsed wood by steaming was investigated at the Forest Research Institute, Dehra Dun, and the results obtained with toon are summarised in Table II.

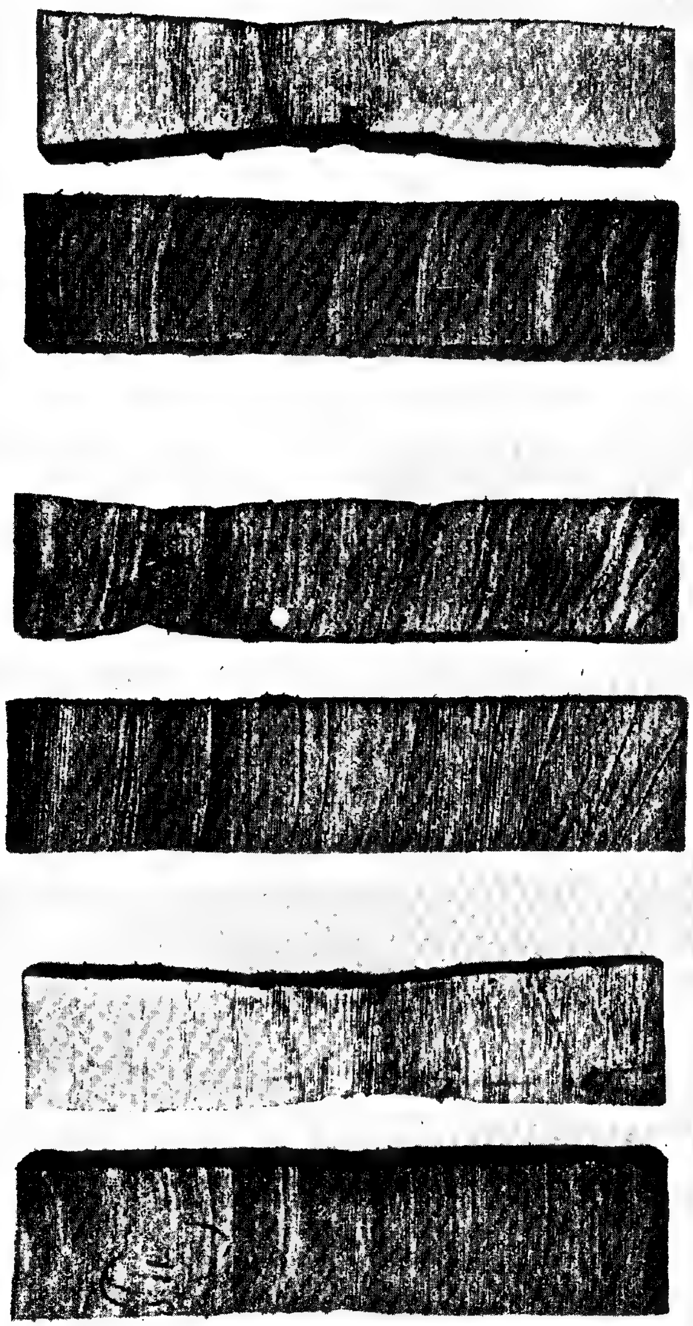
TABLE II

Results of conditioning treatment for removal of collapse in toon.

No. of experiment.	Kiln type.	Period of steaming.	Moisture content initial.	INCREASE AT THE END OF STEAMING.			INCREASE AFTER AIR-SEASONING.		
				Moisture content.	Breadth.	Thickness.	Moisture content.	Breadth.	Thickness.
		Hours.	%	%	%	%	%	%	%
1a	Steel cylinder ..	6	13·0	5·7	1·73	5·77	0.1	1·00	4·69
1b	Steel cylinder ..	4	13·4	3·7	1·49	3·37	−0·1	0·96	2·72
1c	Steel cylinder ..	2	13·2	2·5	1·16	..	0·2	0·92	..
2	External blower kiln ..	6	11·9	5·6	1·67	..	−0·7	0·65	..
3	Internal fan kiln ..	6	9·1	5·6	..	..	−0·2	1·06	..

Five charges of badly collapsed one inch thick boards of toon were tried, three in a steel cylinder (meant for vacuum drying), one in an external blower kiln and one in an internal fan cross flow type of kiln. The best results were obtained by steaming in a steel cylinder, where a temperature of about 100° C. could be easily maintained. After six hours' steaming practically all the collapse was removed, even in the pieces having the worst type of collapse. In the external blower kiln, it was not possible to attain a temperature higher than 90° C., and the humidity was probably much below the saturation point, although the consumption of steam was much greater than in the steel cylinder. In this case it was observed that not more than half of the original collapse was removed, although the treatment lasted for six hours. The results obtained in the internal fan kiln were better than in the external blower kiln, but even these were not as striking as in the steel cylinder. Later on, various confirmatory tests were carried out and in all cases a steel cylinder proved much superior to a brick kiln for this purpose.

During the process of steaming, there is a gain of moisture from 3 to 5 per cent., but after air seasoning the pieces for a week or two,



this extra moisture is evaporated, and measurements taken at this stage show a permanent increase of about 1 per cent. in the width of the planks. On account of the irregularity in cross section of the pieces due to collapse, it is difficult to measure the increase in thickness, but there is a considerable gain as will be evident from the photographs of the ends of specimens before and after treatment illustrated in Plate 46.

In another charge some planks were included which were collapsed badly on the surface, but were not yet fully dry in the interior, containing as much as 40% to 50% moisture in the core. It was found that the conditioning treatment had no apparent beneficial effect on such pieces.

Similar experiments on other species have not been equally successful. In the case of *Schima wallichii* and *Quercus lineata*, which are liable to severe collapse even during air seasoning, steaming for six hours in a steel cylinder was practically ineffective. A further steaming for 10 hours did not give any markedly improved results. On the other hand it was found that the process of steaming caused surface cracking in some of the pieces. The ends of planks showed some gain in size, but apart from this, the condition was as bad as before. Slightly better results were obtained in the case of planks of *Machilus* spp. and about half of the collapse was found to be removed from planks of *Acrocarpus fraxinifolius*.

The steaming treatment has been found to be definitely beneficial only in the case of toon, and not for other timbers so far tried.

4. *Shrinkage and swelling of collapsed wood.*

An investigation was carried out to determine whether the collapsed portion from a plank of toon behaves differently as regards shrinkage and swelling with changes in atmospheric humidity as compared with a neighbouring sound portion from the same piece. Sections were obtained, $\frac{3}{4}$ inch × $\frac{3}{4}$ inch in cross-section, 4 to 5 inches in length, from adjacent collapsed and un-collapsed parts from 5 planks of toon, and these were allowed to attain equilibrium at various relative humidity conditions. The average values for the five sets of specimens are shown in Table III.

TABLE III

Swelling and shrinkage of collapsed toon.

Property.	Specimen.	Relative Humidity.		
		84%	60%	28%
Moisture equilibrium ..	Not collapsed ..	17·5	11·1	5·9
,, ,, ..	Collapsed ..	17·4	11·2	6·2
Tangential shrinkage to oven-dry condition.	Not collapsed ..	5·06	3·06	1·30
,, ,,	Collapsed ..	6·01	3·77	1·59
Radial shrinkage to oven-dry condition.	Not collapsed ..	3·34	2·10	0·94
,, ,, ..	Collapsed ..	3·33	2·09	0·97

The results show that the presence of collapse dces not affect either the equilibrium moisture content or the shrinkage and swelling in the radial direction, which values are practically similar for the collapsed and un-collapsed specimens. The shrinkage in the tangential direction, on the other hand, is increased, which appears to be a direct result of the collapse, which takes place in that direction. This increased shrinkage cannot be accounted for by an increase in density of the wood, as that would affect shrinkage in both the directions more or less equally, which is not the case.

5. *Summary.*

The following observations on the incidence of collapse in toon are recorded :

(*i*) The tendency to collapse varies in different trees, even those growing in the same locality.

(*ii*) The material from the butt end is more prone to collapse than that from the top of a tree.

(*iii*) Heartwood from near the sapwood zone has greater liability to collapse than wood from near the heart-centre.

(*iv*) The severity of collapse is increased by drying at high temperatures in a kiln.

(*v*) During air seasoning from green condition, high humidity weather in the early stages of seasoning causes more collapse than dry weather conditions.

(*vi*) Even small end sections are liable to collapse nearly as much as long planks.

(*vii*) The first appearance of collapse is noticed at about 50% to 60% moisture content, and most of the collapse occurs before the wood reaches the fibre saturation point.

2. It has been possible to remove collapse from pieces of toon, even when badly affected, by steaming for 6 hours at about 100°C.

3. This conditioning treatment is not effective in the case of *Schima wallichii* and *Quercus lineata*, and only partially useful for *Acrocarpus fraxinifolius* and *Machilus* spp.

4. Steaming in a steel cylinder gives better results than in a brick kiln, and an internal fan kiln is superior to an external blower kiln for this purpose.

5. Collapsed portions of toon show higher shrinkage in a tangential direction as compared with the adjacent uncollapsed portions, although the shrinkage in a radial direction and the moisture equilibrium values are not affected.

THE ROLE OF THE MANUFACTURE OF SMALL DIMENSION STOCK IN RURAL UPLIFT

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Both the Government and the politicians of India have on the anvil the framing of a comprehensive programme of rural uplift. As many ills in India, especially in the villages, are due to the chronic and appalling poverty of the villager, any proposition that is calculated to improve his earning capacity deserves the careful consideration of the public.

The writer was very recently engaged in advising the Government of an important Indian State on timber utilisation, and he worked out an idea that bids fair to be practicable and applicable to most

Indian villages. The idea relates to the manufacture of "small dimension stock" by practically unskilled labour in rural areas. Such a manufacture capitalises only what the illiterate villager is capable of since all that is necessary is the use of a hand saw and a wood axe.

The expression "small dimension stock" originated in the United States of America. It refers to wood pieces of different standard sizes, generally varying in thickness and width between ½″ and 6″ and in length up to 8 feet. This stock has a ready market in towns and cities where wood-working factories or workshops, including turneries, may be or are already located. The stock may be straight and rectangular in cross-section, it may be curved or bent and may be of different cross-sectional and longitudinal dimensions. In more general terms, small dimension stock is wood planking of small sizes that can be cut from slabs and trimmings, or pieces cut from small logs of different irregular sizes. It finds its chief market in wood-assembling and finishing factories. In India, the small dimension stock idea is already current although only in an embryonic form such as in the case of bed-legs, but a more scientific, systematic and extensive production of small dimension stock has enormous potentialities for the elimination of timber waste to a minimum, and for starting a new rural industry of far-reaching importance. As far as the aspect of the rural production of small dimension stock is concerned, the average villager can produce only the more simple forms with rough finish like blanks for turnery work, legs of chairs, tables, etc. The more skilled artisans of Indian villages, like the village carpenter, can plane also the stock, or turn the blanks into different useful forms for chair legs, toys, brush-handles, curtains, rods, etc. It may be added that although small dimension stock is cut from small logs, it is a higher grade of material (with neither knots nor decay) than structural timber, or large dimension stock.

There are various sources of raw material for the manufacture of small dimension stock. The small and irregular pieces of timber left over during conversion of large logs into sleepers, building timber, etc., are one important source. Such pieces are usually consigned to

the fire at present. In some parts of the country, especially in the drier regions of India, there are several valuable trees which either give only a straight bole that is short, or a clear bole of comparatively small diameter, say below 12" to 14". In the case of conversion of the larger logs, the smaller sized tree-tops, edgings, slabs, trimmings, etc., form excellent basis for the manufacture of small dimension stock. Crooked or small-sized logs, slabs, and edgings contain different proportions of small dimension stock which can be cut out just as well from such low-priced material as from high-priced large-sized logs.

The next aspect that requires consideration is the scope that may be reckoned to exist for the use of small dimension stock. Obviously, any one who employs timber articles or minor structures in the final form of sizes not larger than 6" × 8" in cross-section, and not longer than 8 ft. will buy such material if it is cheap. Practically, any kind of wood, hardwood or softwood, that is available in the forest will be suitable for the purpose, and as the material is manufactured with inexpensive rural labour from waste timber, it must be easily able to compete with such stock cut in towns and cities by expensive labour from costly large-sized logs.

It is no exaggeration to say that over 95% of the timber that is required in practically any wood-using industry is included within the limits of size of small dimension stock.

In an actual survey of timber used in wood industries in America, it was revealed that only 1% is employed in over 5 inches' width or thickness, and over 8 ft. in length. Again, over 50% of the timber used in American wood industries was found to be less than four inches square and two feet long. It will be, therefore, seen that there is a very large field for the use of small dimension stock in wood industries. The manufacturer of such stock requires the most elementary skill, and some of the poorest grades of timber.

Some of the consumers of small dimension stock in wood-using industries may be classified as follows :—

1. Buyers of many different sizes, *e.g.*, furniture makers,

2. Wood turners who require blanks, *e.g.*, furniture makers, toy makers, brush and tool handle makers, insulator pin and shuttle makers.
3. Users of bent timber, *e.g.* furniture makers and makers of sporting goods.
4. Buyers of timber in different stages of finish and assembly, *e.g.*, furniture makers, toy makers, cart and wagon makers, truck makers.
5. Industries in which standard sizes are employed, *e.g.*, cooperage stock, box and crate shooks.
6. Buyers requiring air-dry pieces, *e.g.*, furniture makers.
7. Users who require certain types of cutting or sawing, and, in some cases, certain qualities, *e.g.*, furniture makers and sliced veneer users.

In Germany, Austria, Czechoslovakia, and Holland, to mention a few among the European countries, the use of small dimension stock has become extensive. Japan has followed suit, and she is importing into India small dimension stock for packing cases and crates. She has been making tennis rackets with small waste pieces of different timbers.

The following are some of the more important wood industries that can employ small dimension stock on a large scale.

1. Makers of agricultural implements like ploughs.

2. Makers of tongas and carts spokes, and their parts like felloes, hubs, etc., wheel barrows, trucks, motor car bodies and wheels, etc.

3. Makers of boxes, crates, barrels, poultry coops, signs and advertsing boards, patterns, templates, tubs, water tanks, etc.

4. Makers of sporting goods like tennis and badminton rackets, hockey and cricket bats, poles, etc.

5. Makers of chairs, benches, stools, tables and other articles of furniture, etc.

6. Makers of handles of brushes, brooms, garden and machine tools, etc.

7. Turnery workers making shuttles, spools and bobbins, woodenware and novelties, toys, patterns, flasks, etc.

8. Makers of small machines like spinning wheels, weaving machines, framework for sugarcane crushers, etc.

9. Makers of doors, windows, ventilators, panel as well as trellis partitions, wall-brackets, shingles, casing for electric work and house-building components.

10. Miscellaneous small-sized wood-ware like door knobs, parts of indoor games, like chessmen, draughts, etc., curtain rods, shoe-lasts, paper-weights, blotters, cups and saucers and also for articles for which blanks are required to enable manufacture on a large scale in automatic or semi-automatic machines.

Having surveyed briefly the field of use for small dimension stock, the question of its manufacture and disposal in Indian villages may be considered.

Man is a victim to tradition, style and habit. The Indian villager is no exception. He has been used to selling timber mostly in the form of logs, scantlings and *balis*, for building construction, and railway sleepers. If he is to start making small dimension stock, he must be naturally convinced that it is profitable to do so. As far as the manufacture of small dimension stock in Indian villages is concerned, there are really only two aspects to be considered, as under the present conditions of poverty and lack of education of the Indian villager, one cannot expect him either to instal machinery, or perform complicated wood-working operations even with his hands. The villager's ability to invest only a very few rupees of capital and his poor ability as an artisan are two potent factors that must circumscribe any industry that may be prescribed for him.

At the present time, it is only possible to expect him to use a hand-saw, which costs less than two rupees. It is also a tool which lasts for a long time without being easily damaged provided the village carpenter sharpens its teeth with a file occasionally. The average village carpenter is able to do this work. The villager can, therefore, prepare rough-sawn stock from slabs and edgings left after the conversion of logs into sleepers and scantlings, etc., which may

be bought for a small sum of money. He can also cut such stock from poor logs of small girth.

The villager can purchase crooked and knotty logs from the neighbouring forest, and after cutting out the defective portions, he can make the best grades of small dimension stock. In north-west Bombay Presidency, Central Provinces and in the Central Indian States, the trees are of stunted growth so that the boles are usually crooked. Such logs fetch at present a very low price. As they will be ideal for the preparation of small dimension stock, the royalty on them is bound to improve considerably with its increasing use for small dimension stock. Automatic machines cannot easily compete with man for such cutting out of defective portions, etc., with the minimum of waste. The human brain alone can exercise the necessary judgment. Here is an excellent field for the Indian villager to employ his leisure time for improving his earning capacity, as even the French and German farmer does during the months when farming does not occupy his time. The Indian villager has at least 160 days in the year when he has hardly anything to do on the land.

The skilled village carpenter or village-turner can make the more complicated or finished forms of small dimension stock like bent or curved stock for felloes or tonga rims, certain toys, sporting goods, etc., and also turned articles such as ornamental legs for chairs, beds, etc., toys, chess-men, wood tops, yo-yo, cups, etc. It is well-known that there are dotted throughout the country several villages where there are professional wood-turners who even now turn out articles of excellent finish with comparatively simple and crude locally-made tools.

It has been found, in actual studies, that in small-sized logs, when cut in machines to their full length, the waste may vary between 30 and 50%, whereas if the same logs are first cross-cut into shorter lengths, and rectangular flitches are then cut out, the total waste drops down to 10 or 15%. This is easy to appreciate.

The following are some of the advantages of sawing small dimension stock from crooked and knotty logs overconverting them

into planks :—

1. Less skill required.
2. Less waste.
3. More accurate cutting.

It may be stated, however, that the villager should examine the boles carefully, and decide wisely as to where he can cross-cut the logs with advantage. Such knowledge becomes more perfect with time and experience if once a start is made under proper guidance.

The next question that arises is "What are the most easily marketable sizes, and what is the order of such sizes." In the unorganised condition of timber industries in India, it is very difficult satisfactorily to answer the question, but an attempt may be made based on the experience of various other countries of the world. In such a consideration, there are really two aspects to be kept in view. Firstly, there are slabs and edgings left after converting logs into sleepers. These are available in most parts of Northern India, and on the West Coast. Secondly, there are short crooked or small-sized logs which are available in all the drier regions of the country.

The following are some of the sizes (given in the approximate order of importance) that can be cut out from hardwood slabs remaining after conversion of logs into scantlings and sleepers :—

$2'' \times 2\frac{1}{4}'' \times 6'$
$1\frac{1}{2}'' \times 2'' \times 2'\text{-}6''$
$1\frac{1}{4}'' \times 2\frac{1}{2}'' \times 2'\text{-}6''$ and $5'$
$1'' \times 1\frac{1}{2}'' \times 2'\text{-}6''$ and $1'\text{-}6''$
$1'' \times 1'' \times 1'\text{-}6''$.

Railway sleepers may be manufactured from logs, wherever it is possible to do so, since there is not only a ready market for sleepers, but all the defects are centralised in one unit, and there is a minimum of sawing and other labour per unit volume. The slabs and edgings may be employed for manufacturing small dimension stock.

In the case of the second class of material that fetches a poor price at present—namely, small-girth logs, some of which may be

short or crooked, the following sizes may be cut with advantage :—

$5'' \times 4'' \times 7'$ and $4'$-$6''$
$4'' \times 4'' \times 7'$ and $4'$-$6''$
$3\frac{1}{2}'' \times 4'' \times 6'$ and $3'$
$3'' \times 3\frac{1}{2}'' \times 6'$ and $3'$
$3'' \times 3'' \times 3'$

The above sizes will be useful for the larger parts of furniture, carts and wagons, cross-arms for overhead electric distribution, etc. The square cross-section pieces are useful for turnery work.

The third general class of material that is available from the Indian forests consists of fairly straight lengths, but of low girth, of timber which may be used very profitably, without any cutting or waste, for overhead electrical supports after suitable chemical treatment. We are not concerned, however, with this class of material as there is no conversion and no waste.

Usually, in cutting stock of the largest size grades, defects will prevent material going into such sizes. The defective sticks may be cut into the next smaller size, and so on, so that all the stock pieces are very sound. The smallest size stock will, therefore, be the last size to cut. Also, when accepting an order for the supply of the larger sizes, there may be a stipulation made that a certain minimum of the smaller sizes, say 20%, should be purchased. That is what some of the European small dimension stock manufacturers do.

It will be seen that in the two main types of conversion proposed, in one case, there is the manufacture into small dimension of only a part of the logs—in fact, that which is sold usually for fuel at present, consisting mostly of sapwood slabs. They should be treated with a suitable wood preservative after being cut into small dimension stock as, otherwise, the wood is attacked by fungus and borers readily. In the other type of conversion, the whole log is utilised for making small dimension stock. Most of the hardwoods of India, especially of the drier regions, can best be utilised by converting them into small dimension stock in villages. It is practically only with sal and with woods like venteak, irul and other Malabar woods that the first type of conversion deserves consideration. In the wet

deciduous forests of the West Coast, Bengal and Assam, large-sized logs of *Terminalia*, *Dipterocarpus* sp., etc., are available so that after taking out large-sized timbers for sleepers, building construction, etc., the rest may be converted into small dimension stock, bearing in mind that the largest sizes of the small dimension stock must first be cut out.

Before the very important question of marketing small dimension stock is considered, two of the chief difficulties in the way, namely standardisation and seasoning, deserve examination.

The first requires co-operation and co-ordination between the rural and urban-workers. It is the latter skilled labour that should find it convenient and profitable to purchase the rough-sawn small dimension stock so that it can, either by hand or by machinery, assemble and finish it into manufactured and finished articles. As has been already stated, the urban skilled artisan can get the blanks for his work at a lower cost than at which he can produce the small dimension stock from large-sized logs. In fact, in many cases, it does not pay for the town-skilled labour to convert slabs, edgings, small-sized and crooked logs into small dimension stock as they have to pay higher rents, and more freight on such waste material. Also, their standard of living is higher, and they expect higher wages and profits than the villagers. If the stock is manufactured right near the forests in the villages, the handling and freight charges on the waste material left after the small dimension stock has been extracted is saved. If the small dimension stock is sold to the agents of town workers, after it has been seasoned in small sizes in the villages, the weight of the wood to be handled and transported will be less.

There is a further advantage that for the same weight of slabs, edgings, crooked logs, etc., only about half the space will be required to carry the rectangular sawn small dimension stock, as the latter can be packed compactly (almost solidly) in carts or lorries for transport to towns.

As far as the difficulties in standardisation are concerned in India, there should not be much trouble. For example, in furniture manufacture, very few people are punctillious as regards style and

fashion. As long as it is a comfortable and strong piece which is not expensive, practically any type of furniture, or any other wood article finds a ready sale in India. The majority of people are too poor to be able to pay for æsthetics even if some of them have such ideas so that the question of low cost and serviceability are almost the two paramount considerations for the wide sale of anything in India.

With reference to the second difficulty, namely seasoning, it should not be very serious as timber in the smaller cross-sectional sizes of small dimension stock dries up easily and without much degrade, provided the pieces are piled in tiers, providing channels for air to circulate freely. Those timbers that are prone to split badly should be piled closer so that the rate of evaporation of moisture from the wood is retarded. The average Indian villager, has enough common sense to do this properly if a little guidance is given.

In the marketing of small dimension stock, which may be made a lucrative rural industry, for some years to come, there should be *liaison* agents or salesmen to facilitate a prompt and profitable disposal of the rural production. The great difficulty lying in the path of the translation of the scheme proposed by the writer lies in obtaining the proper type of such agents, who should be given a special training, which can be easily arranged at the Forest Research Institute, Dehra Dun. The agent should not only understand the various physical, mechanical and working properties of the more important Indian woods, but should study the precise need of the town wood-worker and finisher. Otherwise, he can neither persuade the villager to produce the small dimension stock, nor can he find a profitable sale for it so that the whole scheme breaks on the rocks. Good salesmanship requires a thorough knowledge of the product sold, besides all the usual qualifications such as tact, persuasiveness and honesty required for selling.

One of the first difficulties that the salesman has to encounter is about the price that can be realised for the small dimension stock. The salesman should explain the position to the urban hand or machine worker, and convince him that he is getting ready-made rough-sawn stock cheaper than what he can produce by cutting

logs that are usually transported at considerable cost to towns where they are sawn by expensive labour, a lot of the timber being also rejected as waste. He should show the villager that he is getting a decent wage for his labours during about half the days of the year. Until public opinion is created and a powerful all-India organisation comes into existence for the standardisation of parts of wood products (as has been done with metal parts in such articles and machines as motor cars, cycles, boilers, air pumps, etc.) the sale of a high proportion of small dimension stock will be more confined to actual orders booked than to stock manufactured in villages. In Bareilly, one of the most important centres of furniture-making in the United Provinces, there are certain standard designs of furniture made that command a wide market. The result is that the Bareilly worker can compete with other workers even hundreds of miles away as regards certain standard types. As it is the idea of the writer of the article that the manufacture of small dimension stock should be essentially made a rural industry to augment the earning capacity of the villager, it is hoped that the Government and people with public spirit will arrange for the training of the *liaison* salesman, who holds the key to the success of the whole scheme. The scheme may be tried, to start with, in a few areas as an experiment. It may be extended later if it works out satisfactorily. The small producer in the villages requires to be told what sizes he has to produce, and should be paid promptly when he offers the stock. The whole scheme may be worked in some localities, where efficient organisation exists on a co-operative basis. There is ample scope for the Government (including the forest, agriculture and industries department) as well as for the popular organisations aiming at rural uplift to work the scheme. The very keystone of the scheme lies in that the villager should be saved of the worry of finding a market for the shapes and sizes he can produce with the minimum of investment of capital and with very little mechanical skill, and that he should get promptly paid for his products of labour. By the inauguration of a scheme like the one proposed, the country, as a whole, will be gaining by not only reducing timber waste to a minimum and enriching the villager,

but in creating a new rural industry that can compete successfully for a long time to come with the machine and the capitalist.

THE THONDAKULAM ELEPHANT

By A. F. M.

At Easter of the year, 1934, Mr. A. Wimbush, Chief Conservator of Forests, and Mrs. Wimbush, were on tour through the Silent Valley Forest Reserve, a large, uninhabited tract of evergreen "rain forest" and grass-land on the west of the Nilgiri Hills, half-way down to Malabar proper. This is Nilgiri Game Association territory, so Mr. Wimbush, having no shooting license, was going about his work unarmed.

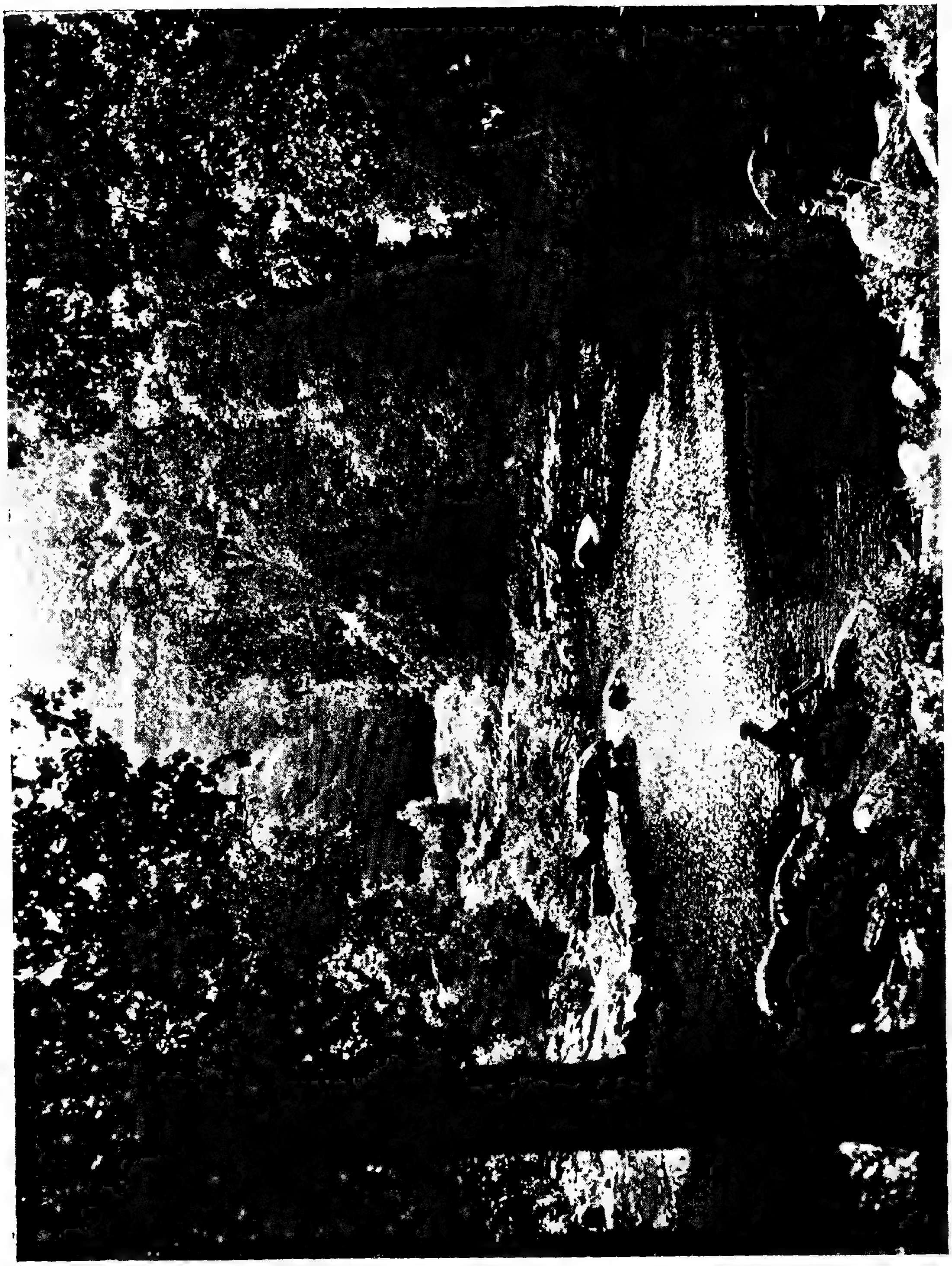
One day, descending a path in a part of the forest that is called Thondakulam* a solitary wild elephant was heard approaching from nearby on the left, evidently in a temper. The Chief Conservator led the party to the right for about 15 yards through undergrowth, so as to take cover behind two trees.

The elephant crossed the path, searching this way and that for the human intruders; and pushed his way into the undergrowth, towards the trees behind which Mr. and Mrs. Wimbush and other members of the staff were concealed. Their anxiety must have been intense, especially as Mrs. Wimbush was holding a little Australian terrier whose slightest sound would have given the show away, and some of the party would almost certainly have been killed or injured.

After a pause of about a minute in which the elephant was listening and testing the wind, he became impatient and made off down-hill along the jungle path at full split, screaming blue murder! and chasing a Forest Watcher who had created a diversion.

Mr. Hamid Khan, I.F.S., a local executive officer, one of the party who went through this experience, made out an interim description of the animal, and shortly afterwards the Collector of Malabar notified it as a 'rogue.' He had misbehaved before, but the incidents had not been taken confirmed by any one in authority.

**Thondakulam.*—(Situated west of the Kanjikumban 4513.)



The Silent Valley—Nilgiri western slopes.

A. F. Minchin, 1934.

The proclamation described him as "about 9 feet high, with tusks of normal shape and curve, protruding to a length of about 2 feet" —that is to say abnormally small tusks for his size.

Lieut. J. R. I. Platt of the Somerset Light Infantry and myself were permitted by the Collector of Malabar to try to shoot the elephant. We joined forces with Mr. J. C. Wrench, I.F.S., the District Forest Officer, at Neelikel camp on the lower edge of the Silent Valley, on the 12th May, and were there or thereabouts until the 18th.

Before we arrived endeavours to locate the beast had been made and were being pursued. Between the 12th and the 16th of May we walked through a great part of the forests; and Moplah scouts were examining the paths for foot-marks in other directions. On the 15th we heard that our elephant had been seen five days back near a village at the base of the hills, below Thondakulam block; and our messengers found also four days' old traces of his having fed in an adjacent reed forest. On the 16th morning we went through the lower part of Thondakulam to see if by any chance he had come up again, but there were no recent marks. It is a marvellous piece of grass-land, stream, swamp and reed forest for an elephant to live in.

Mr. Platt and myself were having lunch in the forest about 2 o'clock on the 16th, and actually were preparing to give up the quest and to retire to Neelikal camp, when two highly delighted Moplahs, who had been scouting in Walghat direction, arrived. And we were still more delighted: for they had chanced upon a fight between what they said confidently was the rogue elephant, and a tusker of one of the usual herds that belong to the Walghat side forest. The latter was having the best of it.

The fight—according to their report had broken off before they left. The solitary elephant had descended towards the slopes on the west whilst the herd had moved on into the main valley.

We set off to where the fight had occurred. We were not too optimistic as to the entire truth of the 'kubbar.' It seemed rather too good to be true! But it can be said now, (and it is noteworthy), that during the whole expedition no untrue or exaggerated information

was produced. The Forest Ranger, Mr. Vasu, had made his dispositions very well.

About three miles north of Poochipara is Hill 4152 on the survey of India map. Between this and a small hill to the south-east of Valia Mullumalai (4084), there is a saddle, and this had been the scene of the affray. As is perhaps well known, an elephant fight—until the critical stages when one tusker's strength is ebbing—is a slow unspectacular process of pushing and shoving, head to head. The idea is first to exhaust the adversary. Fights extend over whole days and over hundreds of acres. I have only seen the results of the final stages of a fight, when the victor's tusks come into play; the wounds tell a tale of torture and horror that one tries to forget.

About 4-45 P. M. we came to the slope down which our elephant was said to have retreated. Matters started to liven up; though I had told Mr. Platt not to expect too much of elephant shooting. Sometimes shooting a rogue is a very one-sided affair and when its huge bulk lies low, one feels ashamed of a facile victory. And, on the other hand, sometimes one gets charged, and that is thrilling enough! Descending we were sheperded carefully by three Moplahs. Two were forest employees and one with a woolly beard, a cooly.

We had to go down a steep hill-side, carrying dense reed forest and an occasional tree. The "reeds"—bamboos really—are about 25 feet high and one clump touches the next. Tracks were confused, and to my disappointment, it was unmistakably the herd itself that was still there. This made us stop and think! Alone, I should perhaps have given up for the day; as apparently the information was not being confirmed by the situation encountered. But elephant herds are always entertaining, particularly when one is in congenial company, so we crept nearer to see what the herd consisted of. The wind was absolutely in our favour and we were uphill too.

The herd was crashing about, eating reeds; so our descent of a wet slippery slope, strewn with debris, did not disturb the elephants. (An elephant herd in its own forest does not seem to have much to worry about!)

From 20 yards off, peeping through the reeds, we made out to our right a small tusker and a big cow ; below us 15 yards down the hill, a young calf ; and behind it, 40 yards away, and difficult to distinguish, the big bull of the herd. He had such big tusks that he could not possibly be Mr. Wimbush's friend.

Wishing to see the big chap more distinctly, but hindered by the calf in the foreground, we skirted away, level to the left, then downwards as far as could be without giving the herd our wind. Mr. Platt and I had at this juncture a capable Moplah watcher called Moideen showing us the way, whilst a Mohammadan Forester, Mammad by name, stuck to my side throughout to help if he could. Moideen scouted a little ahead.

Now our luck began : the very same combat that the messengers had reported, was going on, thirty yards or so below us.

An elephant, bulky but with tusks not more than two feet long, and a not quite so big animal of the herd were the antagonists. The Big Noise of the herd was evidently leaving things to an Aide. The smaller elephant, however, fighting from the higher ground, was having the best of it. Perhaps the other had been knocked about by the big bull earlier in the day : unmistakably he looked downcast. The tusk dimensions and size seemed to square fairly well with the description of our objective ; and the general circumstances pointed to its being the rogue. After being pushed downhill a bit, he turned and tried to escape from the fight, we saw the other ram him effectively from behind. Mr. Platt having a broad-side view fired at his ear-hole. He could see the result better than I could : afterwards he told me there had seemed to be no immediate effect, then the elephant sank slowly and rolled over on to his back. This seemed all right : when an elephant falls to a head-shot with an instant flop it is generally only stunned. Mr. Platt fired into his head again and I put in two body shots. He proved to be far from finished, and began rolling downhill, struggling and turning head over heels. Then whilst we reloaded he got on to his feet and scurried off (right-handed) out of sight.

The other fighter had retreated and the herd, so far as I paid it any attention, seemed judging by sounds to have bunched together. I assumed they would go off peaceably downhill; but actually they charged us, or —more likely—fled up-wind and we were in their way. (We had no time to ask their intentions !) Just as we had been about to start prospecting towards the wounded one, a terrific screaming started suddenly, and a stampede began as I have said in our direction. The wind had probably taken the smoke and our scent to the herd bull!......Things got uncomfortable with a great suddenness....

Through the reeds ten yards away an elephant's head came, straight for us, and we took to our heels.

Though we were adequately armed we did not think of attempting self-defence; the reed jungle being thick was disadvantageous to shooting, as the reeds would as like as not be crashed down on top of us: also I am sure it is ingrained in us to evade rather than attack ordinary wild elephants: and anyhow it wouldn't be much use downing the first comer if there were several just behind him or her.

In medias res, a part of one's mind that only deals with essentials seems to take charge: I am sure this is everyone's experience: natural fears and emotions are extinguished just as the soft pedal of the piano damps the vibrations of the strings.

We escaped by running diagonally uphill and away from the herd's direction, and incidentally (they charged up-wind) edging out of the wind direction as far as the herd were concerned. The charge really was a first-class horror. Holdsworth described a cyclone to me, the other day: "It made the sort of noise an express might make if one was jammed against the wall of a tunnel whilst it rushed by;" well, whilst we were running away, that would describe the noise the herd made, and they seemed to be somewhere just at the backs of our necks!

Whilst on the run there seemed no possibility of glancing back over one's shoulder with a view to firing if an elephant was bearing down on one. I remember realising this indistinctly: we were going at our utmost speed across what were difficulties to an human being,

Feeding ground of the elephants : reed forest in the Silent Valley.

Photo by Lt. J. R. I. Platt (Somerset Light Infantry.)

though they might be little to an elephant: a steep hillside full of rocks, bamboo clumps, and knee deep debris of bamboo stems where elephants had been feeding. It needed all one's mind and eyes to negotiate them at top pace. It is a mystery to me how we got away. Platt and I agreed afterwards that we had been badly scared.

The herd passed and crashed away somewhere below us. The watchers and coolies had flitted uphill to safety with their usual enviable facility. Some were up trees. Immediately after the disappearance of the elephants, we heard another and a veritable avalanche. Perhaps the wounded elephant had dislodged some huge rock. Thinking we were clear, I whistled to Mr. Platt as I climbed a zig-zag elephant track; and listened anxiously, for I felt I had let him down in losing touch. His answering whistle came (he tells me he found difficulty in producing one !) and at that, a big elephant "materialised" thirty yards up the slope above me, cutting off the one line of retreat that we knew! I ducked and hastily retreated round a corner; then Mr. Platt joined the Forester and myself. (Forester Mammad had stuck to me manfully).

I whispered what the position was, and we made our way through troublesome reeds, up a steep slope, in a direction somewhat away from the intercepting elephant, who may very well have been the mother of the calf aforementioned; for as such, she was likely to be on the war-path. The crashings that approached us suggested that she was searching for us.

Again speaking for myself the whole affair had rather jangled my nerves, which are never of the best. Anyhow one *is* shaken when a palpable brain-shot does not "come-off." Sutherland's book tells us—what it is nicer to ignore when after rogues—that elephants occasionally carry on after receiving a head-shot, subsequently *proved* to have been through the brain.

Others of the party joined us. We felt safe when we had scaled part way up a precipice. In doing this, a huge slab of rock came adrift and slithered past me; and Mr. Platt had only just time to dodge it. My next anxiety was whether the crest above would prove scaleable: for it was now night-fall, and raining. Eventually we got

to Neelikal camp at ten-thirty. Whiskey went down very well that night!

We made preparations next day for a pursuit that might involve sleeping the night in the jungle. Our actual search began about noon; for the scene of the fracas is some way from Neelikal. Mr. Wrench came with us but to his disappointment we elected that he must go back to the base and be Officer-in-charge of Supply and Transport.

The blood-trail did not help us very much. Near the last blood-trace that we could find there were tracks of all sizes; and though our trackers tried every trail in every direction, no more blood could be seen. After four o'clock when we were quite at a loss and were giving up hope, we ourselves tried at Mr. Platt's suggestion a trail that the trackers had condemned; and here luck recommenced; nearby, we came upon a "lane" of reeds laid flat, extending towards down-hill. Mr. Platt thereupon discovered some blood traces! As we climbed down we realised that anything that had descended ought to have been killed: and hopes revived. Hope became certainty ....after descending a fifty-foot cliff, it could be seen that the falling elephant had carried away a big limb of a tree and had gone on over another smaller cliff. The cooly (he of the woolly face) beamed at us: there was the dead elephant in the reeds at the bottom of the slope. His path had taken him down about 300 feet.

We left his tusks for extraction on the next day, as it was getting late. (Our photographs also failed for lack of light.) Moplahs say it gives you white leprosy to cut up dead elephants, so we do not ask them to do so!

The creature was heavily built and perhaps 8 feet in height; but in his crumpled condition one might be somewhat out. The tusks were smaller than they had looked at first; the right tusk protruding perhaps 21 or 22 inches, and the other a little smaller.

Mr. Platt's first shot had been as perfect as it could have been, central in the ear-hole. The fall had broken the elephant's neck and mangled his near fore-leg. He bore healed bullet wounds on the

neck, and a number of long deep cuts made by tusks of elephant adversaries. He looked like an unpopular elephant.

In our pursuit, after leaving the Walghat path, and going down to the north face of the hill I did not at the time notice that we had ceased to be in Government forests, and that we were in fact in the forest of the Zamorin of Calicut. Arrangements were made for extracting and cleaning the tusks, which will be kept in the custody of the District Forest Officer until I have received an expression of his wishes in the matter from the Zamorin of Calicut. [He has since very kindly given both tusks to Mr. Platt, and wrote an extremely nice letter.]

During our stay in the Silent Valley we came across fresh diggings by a bear and a very few traces of bison and of sambhur. We saw few if any marks of wild dogs or of tiger or panther.

Mr. Platt and I were struck with the possibilities for trout in the main river if the elevation at the lower end of the stretch, about 2,900 feet (where the rapids begin to descend to the plains) is not too low. The water is dark as in Peat streams. There must be at least three miles of fishable water, much of it through cool evergreen forest. Elephants and black monkeys seemed to be the principal inhabitants of this extremely picturesque valley which looks so ideal for big game.

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CLOSE RANGE LIGHTNING

By J. Abraham, Range Forest Officer, Raver, East Khandesh

Thunderstorms occur a great deal in this district during the months of June and July.

July 9th happened to be a clear day but in the afternoon, whilst marching from one camp to another, I observed huge black clouds travelling across the horizon, and a short time later a most terrific thunderstorm began to rage. The sky was soon overcast and flashes of lightning followed by claps of thunder occurred every few minutes.

Walking through the tree growth, one felt the rumblings of thunder to be more pronounced and threatening, as if the very heavens were bursting and falling.

Realizing the danger, I made for the open and had hardly walked a few hundred yards when I saw a bright streak of lightning suddenly descend to the earth in front of me.

It came down with a most awe-inspiring swish and appeared to me like a bright yellow rod, about a yard in length and about one-sixth of an inch in diameter. The lightning struck an *anjan* tree (*Hardwickia binata*) and seemed to be completely absorbed in it.

A deafening clap of thunder just then occurred ; the *anjan* tree seemed to be virtually halved, and it broke down, the splinters being strewn all over the place.

The incident hardly lasted a few seconds but the scene was most magnificent, and though the flash was so bright, I was so awed and amazed that I could not remove my eyes off it.

On walking up to the tree, a few minutes later, and examining it, I found that smoke was issuing from it and that the core of the tree was neatly burnt into charcoal about an inch in diameter from the top to the base.

Anjan tree struck by lightning which left a track of charcoal right through the tree.*

Rain kept off for a quarter of an hour longer and I was successful in obtaining a good photograph.

I count myself fortunate in becoming a spectator of this unique scene, and more fortunate still to be 400 yards away from the tree when it was thus stricken by lightning.

I had in previous years seen a few lightning-stricken *nimb* (*Melia azadirachta*) and mango (*Mangifera indica*) trees, but as yet had never actually seen lightning at work. These stricken *nimb* and mango trees I noticed had a considerable area of their heartwood irregularly blackened by the passage of the lightning.

I believe that *Hardwickia binata* being a very hard wood probably accounted for so regular and so little of the core of this particular *anjan* tree being burnt.

*Block lent by the courtesy of the Editor, "The Illustrated Weekly of India."

REVIEWS

THE ORGANISATION OF THE CELL WALL OF THE CONIFER TRACHEID

By R. D. Preston, Department of Botany, Leeds University

Philosophical Transactions of the Royal Society of London, December 1934.

The paper describes a most interesting piece of research which gives not only a new and valuable insight into the construction of mature conifer tissue, but by working back from the facts thus established, the author has suggested a means of studying the primitive cell division and cell structure of the meristem of the growing twig and of the formative cambium. The work has led to a working hypothesis that both apical meristem cells and cambial initials have wall structures closely resembling those of adult wood elements. In this study the use of X-ray apparatus has been applied to obtain photographic evidence of the structure of cellulose micelles or fibrils which are the basic fabric of all wood structure.

The meristematic cells of the shoot apex apparently undergo an enormous extension in length, somewhere about 70 times increase, with practically no corresponding increase in diameter, in order to form the tracheid cell of the first year's shoot. Later thickening in the process of building up the annual ring is produced by each

tracheid splitting in a radial direction, each cell retaining a share of the unaltered radial wall on to which is built the new tangential walls. This might be expected to alter the structure of these two planes, and in actual fact this is found to be so, the inclination of the fibril structure of the tangential walls remaining constant, while that of the radial walls alters in direct ratio to the radial breadth. The individual micelles or fibrils which show these definite alignments are built up in a three-dimensional crystal lattice structure. These micelles collect together to form aggregates which in the elongated tracheid take the form of spirals, and it is the study of these spirals and their varying patterns by X-ray which has given this fresh insight into the minute details of wood structure.

The cellulose structure of the wall cannot be regarded as consisting of continuous rigid spirals; it is apparently more in the nature of small elongated particles of wall substance laid down in a spiral fashion, so that each small unit has the same inclination to the long axis of the cell. Apparently a growth process instigated in the cell itself cannot produce any considerable change in the fibrillar direction but growth under tension from without has the effect of steepening the spiral. Working back from the tracheidal structure Mr. Preston has shown that the apical meristem cell would have a winding very similar to the seam of a tennis ball if the cell were completely round, but in actual practice has the shape of a polyhedron, each facet being shaped by neighbouring cells impinging upon it from all sides; the fibrils cross each facet as more or less straight lines, altering slightly in their direction as they turn through the angle made by adjoining facets.

In the case of the tracheid he concludes that "in the absence of any old wall the protoplasm can lay down cellulose micelles in a definite direction over a considerable period, but that when an old wall is present the direction of the micelles in a new layer conforms more closely to that in the old wall than to that imposed on it by the protoplasm." It would be exceedingly interesting to know just how far these findings can elucidate the problem of twisted fibre in chir pine and other timbers, particularly when it is remembered that

twist tends to decrease gradually both with increasing age and with increasing height in the tree stem, and in the case of chir even to become reversed in the topmost section.

R. M. G.

THE GRAMINEAE– A STUDY OF CEREAL, BAMBOO AND GRASS

By Agnes Arber, M.A., D.Sc.

(Pp. 180 with a coloured frontispiece and 212 text figures. Cambridge University Press. Price 30 sh.)

The Gramineæ, or family of grasses, comprises a vast assemblage of plants the number of species of which is estimated to be about 8,000, falling into some 550 genera In its importance to mankind it undoubtedly excels all other families for, in addition to its universal distribution, power of adaption and other economic features, its cereals provide " bread " for the entire human race, wheat and rice, perhaps the latter more so than the former, being the staple food of more humans than any other cereals in the world. To the correspondingly vast amount of literature dealing with this family Mrs. Arber has recently contributed some interesting papers; she has specialised in the study of the Gramineæ and allied families and this new book is the outcome of some years of this study.

The first three chapters of the book deal with the consideration of grasses in relation to man. The reader will find here much of interest regarding the history and culture of the cereals from antiquity, of the races of wheat and barley, of oats, rye, the millets and sorghums, and of rice and maize, the most important crop plants of the East and the New World. The probable home and mode of origin of the countless races of cereals that have arisen under the influence of the hand of man are discussed and some interesting illustrations from early literature are reproduced. The pasture grasses and the sugar and scented grasses are then dealt with.

Four chapters are devoted to the bamboos which, besides the grasses, are of great importance, especially to the forester in the

tropics; much useful and interesting information is given regarding their uses, dimensions, habit, age and mode of growth. The periodicity of flowering, which is annual in some species and ranges in others from a few years to the more prolonged life cycle of thirty to eighty or even to a hundred years or more is discussed; although a great deal of data and information has been accumulated regarding this most intricate and interesting problem of the reproductive phases of the bamboo and its causes, its solution still remains unsettled and calls for more observation and record extending over prolonged periods. Few are in a better position to supply this than foresters in India and Burma and we are very pleased to know that Mrs. Arber has been able to receive great help from the splendid collection of data that has already been placed on record in the volumes of the *Indian Forester* by foresters in India.

There is, in the succeeding chapters, much that is of a technical nature regarding the structure and comparative morphology of the flower of the bamboos and of the grasses in their more restricted sense. The discussion leads from the structure of the flower of the bamboos in general, the study of which, it is thought, is the best starting point towards the proper understanding of the flower of the Gramineæ, to the normal and more aberrant types of grass flowers with their modification due to reduction brought about by crowding and compression during ontogeny.

In the succeeding chapters the discussions cover a wide range from the seed—with another disclaimer regarding the recent reports of germination of "mummy wheat" from the Egyptian tombs and India—to the seedling, the vegetative phase in grasses, the morphology of the shoot, the seaside, sand-binding, shingle and aquatic grasses, their dispersal, hybridism and individuality. Mrs. Arber has also sought to detect within the complex types of this vast family a pattern and rhythm around which she has woven much of interest.

As is often the case in large natural groups of plants, like the families Compositæ and Orchidaceæ and the genera *Eucalyptus* and *Ficus*, the members of the grass family may nearly always be readily

recognised as a group from their general appearance, but the next and subsequent steps in classification become difficult. For detecting affinities and differences in such groups, botanists often rely upon an intuitive faculty which may be cultivated to a high pitch by observation coupled with interest, and it is thought that it was this faculty that led Robert Brown more than a century ago to recognise the two sub-families Pooideæ and Panicoideæ of the Gramineæ; the affinities and differences of these two sub-families, the recognition of which is often a stumbling block to students of the family, is stated in a lucid and interesting manner.

A short taxonomic table of the tribes and genera of the family is given and this is followed by a useful bibliography and an index. The large number of figures which are mostly the work of the author are good.

Mrs. Arber is to be warmly congratulated on the production of this book which, written in a masterly manner combined with a charming style should prove very useful as a text book and book of reference to all students of this most important and difficult family. The printing, material and get-up of the book is of usual high standard of the Cambridge University Press.

C. E. P.

EXTRACTS

COMMON SENSE IN ENGINEERING—ROADS IN HILLY COUNTRY

BY COL. F. C. TEMPLE, C.I.E.

There is one feature essential to all roads if they are to serve their purpose. The road surface and road bed must be so drained that water will not lie on it. The method of accomplishing this for roads among hills is different from that for roads in the plains. In the latter, except at a few places, both the road bed and the road surface will best be cambered from the centre to either side. This will also suit a road running up or down hill, the centre line of which cuts the contours at, or nearly at, right angles. A road which runs parallel to the contours, or on a rising gradient diagonally to the contours, across a side-long slope, is in danger of being damaged on its outer edge by all water which runs off down the hill. The steeper the slope of the hill the greater the danger of injury to the outer edge of the road. The danger is not confined to the surface material of the road. The water is liable to scour the

hillside and may cut into the road bed. It is almost always necessary to slope the road bed inwards towards the hillside, to a drain constructed between the road and the hillside, leading to culverts across the road through which the water will escape down the hillside. It is usually safest to give a similar slope to the road surface. Cambering to either side from the centre is only safe when an efficient drain can be made along the outer edge. This can rarely be done unless there is a continuous parapet wall or parapet-like bank of earth.

The inward sloping of the whole width of the road is important in all roads but least important in a concrete road which is likely to retain its shape and, therefore, if cambered both ways throw off water evenly from the outer half, and so not subject the hillside to a large discharge at individual points. The less permanent the material of the road surface and the more liable to injury or wear, the more important is it to slope the surface inwards. In gravelled roads such as are so common in the Central India Plateau it is essential if the road is to last. It is in the less important of such roads that this is most often forgotten. Forest roads, and others made by people who are not road engineers, are frequently to be found sloping outwards. They are usually cut badly in every heavy rain.

The cross culverts which take the water from the inner drain across the road and discharge it down the hillside need to be placed with great care. Their very purpose is to concentrate flow of water and the better they achieve that purpose the more likely is the water to damage the hillside as it goes down. Natural streams, if they have reasonably stable sides, make the best cross drains. They must be bridged anyhow and they may be capable of carrying an artificially increased discharge. But it must not be forgotten that in bad ground a channel which is stable for the volume of water naturally discharging to it may not be capable of standing up to the increased discharge due to the drain. Natural streams may not be close enough together. It is very difficult to calculate the necessary size of the inside drain. It ought to be big enough to deal with the heaviest rainfall, for during very heavy falls everything is in a disturbed condition and damage is most likely to occur if the drain overflows. It is rarely easy to determine what area of the hill will runoff to a particular length of drain, and even if that can be determined, the rate of runoff must be guess work. The steeper the hillside the quicker will be the runoff and the larger will be the drain necessary to cope with it. As a general rule it is safe to allow for a cent. per cent. runoff at the rate of 3 inches per hour from the whole area discharging to the drain.

The cross drains must be placed at such close intervals that the side drain will not be overtopped. It is best to make them 50 per cent. larger than their size calculated on the basis of 3 inches runoff per hour for the drains. They may be partially choked by silt, leaves or branches of trees. If only of the nett correct size when empty, they will be too small when choked, also if extra large they become capable of dealing with sudden flushes down the drains.

It is a good thing to provide catch pits at the entrances to the cross culverts, to catch debris which would otherwise be liable to choke them ; but these are only useful when they are regularly cleaned out.

When the cross culverts are not in the beds of natural streams, protection must be done on the hillside below their outlets to prevent scouring which may otherwise cut back under the road or scoop out a piece of the hill producing a slip which may take away a piece of the road. It is important that the protective work should be so arranged that, by the time the water passes over it, it is so spread out as to be harmless.

When a road runs up a very steep slope it is sometimes necessary for it to go in zig-zags, possibly with hairpin bends at the changes of direction. In laying out the road the gradient is often calculated on the centre line of the road. This results in a very awkward cant on the road at the turn, steepening the gradient at the inside of the turn. The gradients on the end of one length and the beginning of the next should meet at the point where the outer edge of the upper length meets the inner edge of the lower ; and the actual turn should be made on the level. The level part should extend at least as far from the inside angle formed by those edges as the full length of the road. If space permits the inner edge of the upper length and the outer edge of the lower and the edge of the actual turn should be superelevated to make the act of turning as easy as possible for moving vehicles. This is almost the only place at which the rule of keeping the outside of the road higher than the inner does not apply.

In hill roads in India halting places should be provided for bullock-carts. On a long journey the bullocks are nearly always taken out for some hours in the middle of the day. Such halting places should be outside the ordinary width of the road. They can be made on any comparative level spur, or in a gully, or by making a short level length of road along the hillside taking off from the road itself rather like a run-away siding on a hill railway.—(*Indian Engineering, March* 1935.)

LAND RECLAMATION ON THE LOWER JHELUM CANAL

By L. Ishar Dass, B.SC., M.I.S.E., Chartered Structural Engineer, Punjab Service of Engineers

On the Lower Jhelum Canal the sub-soil water has of last few years risen to alarming levels in some tracts. As a result of the action of salts the lands have deteriorated and good soils turned into alkaline soils. Large areas have thus been thrown out of cultivation on account of the appearance of *Thur* resulting in fall in revenue.

Horse-breeders who hold large grants of lands in this Colony made persistent demands for the exchange of their *Thur* area by good land. Necessity was therefore felt for demonstrating to the zemindars the methods for the reclamation of these lands.

Under direction of Dr. E. McKenzie Taylor, Irrigation Research, Punjab, reclamation was started in 1931 in an area of 11 acres under the control of the Irrigation Department.

In 1932 reclamation was started by the zemindars who were given 80 acres of this type of land on relatively easy terms. The zemindars did all the operations under direction of the Department. As one who was employed lately on the job I would like to state my experience.

The cause of appearance of *Thur* can be described as below :—

"Since the canals were constructed, a rise in sub-soil water-table has taken place. Unfortunately no attention was paid to the drainage problem in the early days. When the sub-soil water came within a few feet of the ground level, it appears that through capillary action the salts came up on the surface and turned good soils into *kallar* lands, which became unfit for cultivation. The remedy that suggested itself was to find effective means of lowering sub-soil water by means of drainage and then do the removal of the excess salts."

The process adopted was as follows :—

In the vicinity of the drains a *kallar* area was selected and soil samples were taken from each field. These were examined by the Director of Irrigation Research, Punjab, in his Laboratory. A special irrigation outlet was given for the land under reclamation and a meter flume was constructed to measure the quantity of water used on the crops in different stages. The first process was to leach the soil. In doing so the soil surface was allowed to be constantly under water for a period of at least six to eight weeks, the object in view was to remove the salts by means of water percolating through the drains. After leaching, the land was prepared for rice. A white variety of rice was selected. This crop can not only stand a certain amount of salt and alkalinity in the soil, but it also ensures that an abundant supply of water is given to the crop which continues the removal of the salts. The yield of rice was taken as an indication of the improvement that had taken place in the soil. Fields which gave an outturn of less than 12 maunds of rice per acre were considered not reclaimed and were prepared for a further crop of rice.

Fields which gave an outturn of more than 12 maunds but less than 16 maunds per acre were considered partly reclaimed and in such fields barley was sown. In reclamation barley is the only crop that can be grown as a winter crop after first rice crop. In the following summer such lands were prepared for rice again. Soils which gave an outturn of more than 18 maunds of rice per acre were considered to have been reclaimed. In these berseem or senji was grown. These green fodder crops can be utilised as a green manure after taking two cuttings for fodder. It is essential to grow a leguminous crop such as berseem or senji after the rice in order to re-establish the nitrogen balance. During the following *Kharif* Desi cotton of Mollisoni variety was sown and also one acre of sugarcane of Co 205 variety was tried which was ratooned the next year. During the period of three years the whole of the area taken up for reclamation by Government agency has been reclaimed and normal crops of rice, sugarcane, cotton, senji, berseem, barley and wheat have been grown.

Under the zemindari conditions tenants have by this time reclaimed a large portion of the land allotted to them in 1932. It is hoped that within the next year or so the fields that require further crops of rice to be grown will be completely reclaimed.

The initial experiments were made directly by the Irrigation Department, but following the successful demonstration the methods were taken up by zemindars supervised by Bh. Tara Singh, a representative of Dr. E. McKenzie Taylor, who remained at the site and directed and recorded the reclamation operations.

After about three years' work it has been found that the reclamation of land can be successfully undertaken and the conclusion has been drawn that the process of reclamation of *Thur* land is commercially sound even if we do not take into account the increase in value of reclaimed land which in itself is a great asset.

Having reclaimed a relatively small area the writer is proposing to his superiors that another experiment should be started on a large scale to establish that large areas can be reclaimed and that the reclamation of *Thur* land is commercially sound.

The writer is thankful to Mr. M. L. Mehta for his discussing this article with the Director of Irrigation Research, Punjab, and making useful suggestions.—(*Indian Engineering, February* 1935.)

NOTE ON SOME FACTORS WHICH HAVE CONTRIBUTED TO THE EARLY REVISION OF RECENT WORKING PLANS

Most of the shelterwood plans which have been made during the past 15 years have been revised earlier than was anticipated. The application of this system of management to forests which had long been under conservative treatment was bound to be beset with difficulties which could not all have been realised at the time. Other countries have experienced set-backs under similar conditions; the Punjab hill forests provide some exceptional problems, and it is not, therefore, altogether unexpected that some of the more modern plans should have given trouble. In the United Provinces, too, the widespread introduction of systems of concentrated regeneration has not met with the hoped for results in a number of divisions and the experts are now busy revising their ideas. During the past few years many defects in the application of the shelterwood system have become apparent and it is only by carefully analysing the causes and effects that a system of management suitable for Himalayan forests can be evolved. At the Forest Conference in 1931 Mr. Glover in his paper " Some notes on recent changes in Forest management in the coniferous forests of the Punjab Himalaya with special reference to the shelterwood compartment system," did much to clear the situation and to show how this system could be modified so as to make it applicable to Himalayan forests and in particular to forests which had not reached that degree of uniformity usually associated with the shelterwood system. His paper dealt largely with the difficulties that had arisen as a result of the application of a system of management which did not suit, in every detail, the types of forest to which it was applied. The old and the new systems represented opposite extremes of management and Mr. Glover's was an attempt to strike a mean. The present paper is, in a sense, a continuation of Mr. Glover's , but it attempts to deal specifically with what are believed to be some of the main causes necessitating the revision of the earlier shelterwood plans, and in doing so elaborates some of the points brought out in his paper. The thanks of the writers are due to

Messrs. Wright, Samler, Prem Nath, Sundar Singh, Khanna, Jamal and Sher Singh, for notes on the difficulties which have been experienced in carrying out certain plans; the notes have been added as an appendix to this paper (*Not printed — Ed.*) In the main these notes attribute the necessity for early revision of the plans referred to, to the following causes:—

1. Failure of regeneration to keep pace with fellings.
2. Inclusion in the volume yield of large quantities of unmerchantable growing stock.
3. Incendiarism, and in particular the fires of 1921.
4. Effect produced on realisation of yield in regeneration felling where, in mixed crops, the silvicultural requirements of the species require differential treatment.
5. Interference with grazing facilities by concentration of regeneration areas.
6. Unsatisfactory arrangement for supply of timber for right-holders.

The writers have endeavoured to deal with all these points. There are, no doubt, other contributory causes among which may be mentioned the excessive demand made on the capital growing stock in order to fulfil Government contracts. This subject cannot be dealt with here, but it must be noted that the Rawalpindi working plan (Jerram, 1915) was altered so as to include a number of non-P. B. I. areas with a view to concentrating fellings to feed a vast exploitation scheme. The scheme, which proved to be unsound, was eventually cancelled, but not before a great deal of harm, both to silviculture and management, had been done, and it is this mismanagement which has caused some of the present difficulties.

Incendiarism and the fire hazard.—Fire damage may be so serious as completely to upset the smooth working of a plan. The Revised Working Plan for Kulu (Trevor, 1919) which was the first to introduce the Shelterwood Compartment System in deodar and kail, received a serious set-back two years after it came into operation, when round about 65,000 acres of forest were burnt.

Large areas of deodar and kail, many of which were in the Regular Working Circle were wiped out, and all age classes suffered, though pole crops were, perhaps, most seriously affected. The necessary emergency steps, including closure, artificial restocking and realization of the burnt trees were taken in hand. In P. B. I. compartments the available yield was not seriously reduced since young crops suffered most and many of the large trees which were burnt were utilised, but regeneration fellings were anticipated, and reproduction received a severe set-back.

In other forests fire was partly responsible for a realisation of the capital growing stock which was not anticipated in the plan, and the burden of restocking was increased. In other words throughout the division the area requiring regeneration was extended out of all proportions. Surely compensatory measures, including a reduction in the yield and the exchange of undamaged P. B. I. areas with badly burned crops in other blocks should have been undertaken ?

With regard to *chir* forests in particular, the writers feel that it is still an open question as to whether it is possible to bring the woods to maturity in the face of opposition by graziers. Even if the disaster of 1921 is not repeated, the cumulative

effect of small fires which occur from time to time may be considerable and a system of management which will afford both the maximum protection and elasticity to avoid the necessity of revision of the plan in the event of fire damage is essential. At the 1931 conference Mr. Holland drew attention to the 1926 fires in the Rawalpindi divisions, he was of opinion that *chir* regeneration could not be protected from fires, and advocated a change of system. Messrs. Parnell and Pring claimed that *chir* regeneration areas could be protected from fires by various control measures. Subsequently serious fires broke out during 1931 in the Rawalpindi divisions, and during 1932 in Kangra. In all the divisions the necessary control measures were prescribed. In para. 13 of his paper, Mr. Glover stresses the importance of retaining patches of poles and advance growth in *chir* regeneration areas for fire protection purposes, and in introducing this paper, Mr. Trevor stated that "with *chir* irregularity was an advantage and was to be encouraged as it mitigated the fire hazard." It might be argued that a return to the selection system is desirable. *Chir* occupies the low hot hills where a system that reduces the factors of the locality may prove very harmful. Departmental burning, besides tending to reduce the soil fertility, tends to exterminate the oak (*Quercus incana*), which it is most desirable to retain. On the other hand, *chir* regenerates best under a shelterwood, and there are other objections such as the difficulty of satisfying grazing rights, to applying the selection system. The writers consider that the "Punjab" shelterwood system, which encourages irregularity, should be given a further chance and that division of the forests into as small units of management as possible would facilitate protection, cultural operations and the saftisaction of grazing requirements.

Kail is also extremely inflammable, but in the kail zone there are many alternative species that can be introduced. Where necessary, belts of more fire-resisting species such as deodar, walnut, chestnut, ash, etc., could be introduced. It is impossible to prevent fires from starting, but if a definite plan of operations were initiated for each regeneration area, combining belts of less inflammable species and a system of contour paths and, where necessary, vertical fire lines, the fire hazard could be vastly reduced. The question of introducing a greater degree of elasticity in the management is discussed later on.

The grazing burden.—Two of the main functions of the Himalayan forests are prevention of erosion and conservation of the water supply. Both these requirements are fulfilled to a maximum degree by the selection system, and were it not for the difficulties of obtaining a sufficiency of regeneration this system might never have been abandoned. Under selection, theoretically, regeneration should be in progress over the whole forest, and failure to obtain adequate regeneration under some of the old selection plans was in part due to the difficulty of arranging closures under selection management. But the commitments of forest settlements cannot be avoided, and to work the forests on a sound basis we must regenerate the whole area. This implies concentration of regeneration on definite areas. The framework of a working plan must be so constructed that full consideration is given to grazing rights. Under the shelterwood system this may be effected by the formation of local felling series as was done in the case of the Kulu plan (Trevor, 1919).

Even under the selection system it may be possible to arrange for systematic regeneration work under closure. The crops in Himalayan selection forests are rarely of true selection type and it is not uncommon to find compact areas often of considerable size, where artificial aid is necessary. In such cases, where the settlement permits, closure and regeneration of definite selected areas can be provided for. This has been done in the Rawingarh and Dhadi State plan and the Kanawar plan.

The necessity for elasticity.—Working plan prescriptions deal chiefly with the three main elements of management :—

(*i*) The silvicultural system,

(*ii*) Yield by volume (or number of trees).

(*iii*) Regeneration by area.

At present we are still uncertain of much of the data on which both the frame-work and prescriptions of working plans are based. This being so, it is evidently unwise to enforce rigidity. The more elastic a plan is the less likelyis there to be a breakdown in the face of faulty prescriptions or unforeseen catastrophe. But if there has, in recent plans, been rigidity, it would be a mistake to go too far now in the opposite direction and a middle course must be followed.

The frame-work of a plan is based mainly on the following data :—

(1) The enumerated volume of the growing-stock.

(2) Degree of normality of the age-classes.

(3) Geographical distribution of the age-classes.

(4) Density of the growing-stock.

(5) Volume increment or diameter increment.

(6) Area to be regenerated.

(7) Regeneration period.

(8) Size of timber required to meet the market demand.

Where crops are even-aged and pure these factors can be assessed with a greater degree of accuracy, but when they are mixed and irregular the only factor that can be known with certainty is the enumerated volume ; even the area to be regenerated cannot be calculated accurately in a P. B. I. under the Punjab Shelterwood System, for it depends on the amount of pole crop retained.

The Silvicultural System.—The working plan lays down the objects of management, the silvicultural system is designed to bring these objects to reality. It is not possible for a working plan officer to prescribe in detail a silvicultural treatment whichis sufficiently elastic to dealwith the vast number of silvicultural circumstances that will be met with. Certain principles he must lay down and, for the rest, the measures by which the objects of management may be obtained should only be suggested. The executive must be left with a free hand to deal with the practice of silviculture. It was shown in Mr. Clover's paper that in P. B. I. forests marking officers may have to deal with selection type crops, pole-cum-tree crops and pure pole crops as well as regeneration fellings, and in other blocks a great variety of crops will have to be dealt with. In this connection the writers wish to stress the necessity for a close correlation between the objects of management and the silvicultural system and this should be clearly set out in a plan. When marking a forest, the

marking officer must not only appreciate the silvicultural requirements of the forest, he must also be mindful of the objects of management ; in other words, marking should be made with a definite silvicultural idea.

The Yield.—For the Punjab, where only timber of large dimensions finds a ready market, it can be accepted that the basis of yield calculations should be the volume of merchantable timber produced annually. The method was explained by Mr. Glover at the 1931 conference and was first used in his plan for Balsan State. The above figure does not necessarily represent the true yield capacity of the forests and it was shown that other factors, such as the amount of regeneration present, must be considered before a satisfactory yield can be fixed. Failure to take some of these factors into account has led to mistakes being made in the past.

Abnormality in the age-classes may necessitate a faster or a slower removal of merchantable timber than that calculated, as when there is an excess of old woods or a deficit of middle-aged woods. The geographical distribution of the age-classes and the oecological distribution of marketable species may be such that a proportion of the mature timber may not be silviculturally available when the time comes for it to be felled. It is never possible to fell all mature trees that are scattered throughout forests outside P. B. I. and in many hill forests, Kulu for instance, mature deodar is found scattered throughout other coniferous and broad-leaved woods. In Kanawar middle-aged trees are so widely distributed that when the time comes to regenerate that age-class concentration will not be found. Low density may require an under-assessment of the yield in order to build up the growing-stock.

Crops growing under unfavourable conditions of climate or soil frequently carry large sized trees of great age ; under such conditions age-class has no meaning and the removal of such trees can only be effected at long intervals. Such is often the case where compartments cover a considerable range of altitude.

All these factors have to be considered when calculating a yield that can be sustained. The calculated yield, so modified, represents what is considered to be the yield capacity of the forests and represents a compromise between the requirements, often conflicting, of management and silviculture. This yield is ordinarily calculated separately for each working circle. Under shelterwood management P. B. I. is allotted and the volume of trees of the controlled diameter classes provides that proportion of the circle yield available from that block, the balance, if any, is removed from other periodic blocks in accordance with the objects of management.

The circle yield is fixed as a maximum but within the circle sufficient elasticity must be allowed to the executive staff to deal with the many silvicultural problems that arise. It is not considered necessary to control the P. B. I. yield and the yield from other blocks separately, but in the working plan should be recorded the working plan officer's estimate of the expectancy of each compartment ; this will be useful in framing felling programmes and, if also recorded in the control forms, will facilitate the scrutiny of the felling programme and control forms by the Conservator.

Increment and Pole Crops in P. B. I.—In the Punjab increment is reserved against contingencies, a conservative and therefore excellent scheme, since there has been a tendency to overfell and to accept too optimistic rotation figures. The periodic

increment depends mainly on crop quality which changes greatly within very short distances in hill forests. Within P. B. I. the reservation of increment may have some effect on the operation of fellings. It depends on the amount of pole crops retained and on the number of trees passing up into the controlled classes during the period. The increment on the former can be ignored as they are below the controlled classes. Increment depends also on the nature of the fellings made; light seeding fellings would afford greater increment than heavier fellings over a smaller area; where I and II class trees are counted against the yield in P. B. I., by removing a greater proportion of I class trees in seeding fellings, a larger proportion of II class trees are left to become I class and a greater increment accrues. Thus the exclusion of increment from yield calculations may force an extension of the period and is tantamount to under-estimation.

The forests of Balsan State (Glover, 1926) afford a concrete example. The period of the present P. B. I., which includes a number of partially regenerated woods, is 15 years. The crops consist chiefly of kail and deodar. The proportion being roughly 2 : 1. The plan, which is the first of the Punjab Shelterwood system, is working very well. P. B. I. areas consist largely of diseased kail crops which it is inadvisable to retain. No assessment was made for increment, and the volume of I and II class trees was counted against the yield. Trees of III class diameter dimensions greatly out-number I and II class combined and as there have been no fires, the increment from the passage of III class to II class accounts for the necessity of increasing the yield in order to avoid a heavy area lag. It is inadvisable to delay operations in P. B. I. because it is necessary to replace diseased kail woods by a healthy kail-deodar mixture; therefore, it is obligatory, in this case, to increase the yield. The remedy lies in making re-calculations or estimates of the yield after comparatively short periods, say 10 years, where it is obvious that effects of reserving increment are likely to react adversely on management. This does not necessarily involve a revision of the plan, and breakdowns can be avoided. By basing the yield on merchantable stock only, most of the difficulties which arise from including a large quantity of small material are avoided. However, difficulties may arise for the following reasons. If the marking officer, with reasonable justification, retains a greater area under pole-cum-tree woods or treats a greater areas as selection type than was allowed for, then he will not find his yield. In practice all goes well to begin with, but some time during the second cycle the shortage will make itself felt; obviously he cannot then regenerate pole-cum-tree crops, and he is forced to scatter his fellings so as to make up his yield wherever a sufficiency of regeneration permits further fellings. In the end he is forced to reduce the yield or to find extra yield outside. In such cases underfelling produces all the results of overfelling. An intelligent application of the silvicultural system is the only remedy.

Volume control in mixed forests.—In mixed forests it is rarely possible, for silvicultural reasons, to mark the same proportions of each species at any one time. For example, a mixture of deodar and kail is generally marked in such a way as to increase the more valuable species. On principle it is best to fell the inferior diseased and rotten trees in heavy seeding felling to clear the regeneration area of rubbish by

burning at once and to disregard proportions. Such being the case where a separate yield for each species is prescribed, the marking officer is either obliged to scatter his fellings so as to cut the correct proportions of the various species prescribed, or else he must, in the interests of silviculture, ignore the yield prescription. As regeneration fellings proceed, fellings tend to become more scattered and the difficulty is aggravated. The writers are of opinion that for mixed forests managed under the shelterwood system a combined yield, such as was prescribed in Trevor's Kulu plan, is desirable. In conjunction with this a felling programme, covering say three years, should be prepared annually in the divisional office. This programme will enable the Conservator to regulate fellings, within reasonable limits, to meet market requirements.

The relation between area to be regenerated and yield.—The system of control adopted in Punjab coniferous forests managed under a shelterwood system is by area with a volume check, and an equal annual outturn is usually prescribed. The basis of control is, therefore by area, and under the Punjab shelterwood system regeneration is obtained in a fixed block, its proportion to the total area being equivalent to the time fraction, period/rotation. For financial reasons it is usually desirable that there should be as little fluctuation as possible in the value of the annual outturn, in other words the rate of realisation of the volume yield throughout the period should be constant. Area control implies completion of regeneration on P. B. I. in a given time, and a rigid closure scheme imposed by settlement rules may increase the necessity for establishing regeneration over the whole block within this period. The point at issue is, what is the relation between the rate of felling and the area covered at each felling? Or, in other words, is it possible to ensure completion of regeneration while at the same time realising the P. B. I. yield in equal annual instalments throughout the period?

One important factor which affects this matter is the silvicultural requirements of different species which require varying intensities of felling. But in the first instance let it be assumed that P. B. I. has to be regenerated in 30 years; then (ignoring increment) if it were decided to remove 50 per cent. of the volume in seeding fellings, the whole area would be gone over in 15 years if the prescribed yield is removed in equal annual instalments. The completion of the seeding fellings in half the period allowed is, for most conifers, none too soon. But now silviculture has to be considered. The removal of 50 per cent. of the growing stock at the first regeneration felling would be too light in most cases. Apart from silvicultural considerations, experience has shown that large accumulations of felling refuse after secondary and final fellings are most undesirable. Conditions vary, but for deodar and kail a seeding felling intensity represented by a removal of 60 per cent. of the growing stock would not be too heavy, while for *chil*, it would be considerably greater. Assuming that the whole area must be in the seeding stage at the end of half the regeneration period, it follows that for the first 15 years of the period the prescribed annual volume yield must be exceeded to ensure that the area prescriptions can be carried out. The case of the Hoshiarpur plan (Mohan) provides an example. Here it was found that the prescribed annual yield was insufficient to allow regeneration fellings of the

required intensity to cover the whole area in sufficient time to establish regeneration; in this plan management was based on a closure period dictated by the settlement rules. In his note, Mr. Wright, citing the case of some of the Gali forests, points out that even if seeding fellings are completed half-way through a 30-year period there is little likelihood that regeneration can be sufficiently far advanced to permit of the prescribed yield being available under the secondary fellings, which must cover the ground at least at twice the speed of the seeding fellings. This introduces another factor, the length of the regeneration period. In practice P. B. I. frequently includes advance growth but whatever the condition of the crops may be it is evident that in framing prescriptions for shelterwood plans, the period required to establish regeneration, intensity of regeneration fellings and availability of the volume yield must all be considered together if the plan is to be a success. Conditions will vary everywhere, but it is evident that there must be some preconception of the difficulties that may arise so that steps can be taken to avoid a breakdown, and it is hoped that the suggestions which follow will help towards a general solution of the problem.

It is assumed that control is by area, with a volume check representing the yield capacity of the whole working circle.

I. By exceeding the average annual circle yield when making seeding fellings.—In cases where settlements allow for closure a shorter time than is considered necessary to establish regeneration and where little or no yield is available from forests outside P. B. I. it would be necessary to complete seeding fellings at as early a date as possible, and this implies a proportionately increased rate of felling in the early stages.

II. Long regeneration periods.—(*a*) In some cases a long regeneration period might be feasible. Theoretically seeding fellings would continue for a very long time; in practice the first or second revision would probably insist on completing regeneration over the more advanced compartments for the sake of the underwood and to be able to open areas to grazing at an earlier date. In practice, therefore, this method resembles the French *quartier bleu* system, and it could be perpetuated by throwing out completed areas and bringing in fresh ones at revisions.

(*b*) On the other hand, where grazing rights permit a sufficiently large total closure, to be under regeneration at one time, the method would resemble *Femelschlagbetrieb*. Periodic increment would be enormous, and if not included at the first calculation, the yield should be increased at subsequent re-calculations, provided the progress of regeneration was satisfactory. This method of management seems suitable where a long waiting period is necessary (*vide* Mr. Wright's article "A note on the Hazara N.-W. F. P. working plans," *Indian Forester*, November 1934). It might also be tried in high level fir forests. By adopting a rotation of 200 years and a regeneration period of 50 years, never more than 1/4 total area need be closed at the one time, probably considerably less for part of the period.

III. An alternative optional yield.—The prescribed circle yield is prescribed only from P. B. I. For P. B. II. crops, thinning will be prescribed, but the working plan will provide that, in the event of regeneration failing to keep pace with fellings or if the yield cannot be found silviculturally in P. B. I. for some other reason, the

yield may be taken from P. B. II, in the form of preparatory or regeneration fellings, depending on the nature of the crops in that block. The working plan would suggest the nature of the fellings and the compartments. This alternative optional yield would be counted against the annual yield, and the plan might limit the operation of this provision to a definite number of annual yields or leave it open, probably the former would be preferable. In any case advantage should not be taken of this alternative until all seeding fellings and such secondary and final fellings as the state of regeneration demands, have been made. At the end of the period there would be standing in P. B. I. a volume equivalent to that cut from P. B. II, under the alternative scheme, which would be carried over into the next period.

IV. Reservation of yield in blocks other than P. B. I.—Many plans have to deal with irregular forests in which present Punjab practice treats merchantable timber outside P. B. I. as yield "geographically out of place" and control its removal, including it in the circle yield. This element of the yield could be reserved against contingencies, thereby allowing greater latitude for the execution of the more important regeneration fellings in the earlier stages of the regeneration period, and creating a reserve which could be drawn on should regeneration fail to come up to expectations. This expediency might conceivably be combined with the suggestions made in III.

The writers believe that the extra scope and elasticity afforded by an alternative optional yield and the manipulation of a yield reserve as described in IV will go far towards preventing failures in working plans and would also be in the interests of silviculture. Such devices would be used for irregular forests for the management of which the executive must be given a fairly free hand.

V. Progress of regeneration.—Theoretically regeneration must keep pace with fellings, and in practice it is a first duty of the executive to see that reproduction is established without delay no matter what provision be made in a plan to allow for difficulties. In practice some advance growth will generally be on the ground but in most cases natural regeneration must be supplemented by sowing and planting. In Kulu and Bashahr a large proportion of the regeneration has been secured artificially following refuse burning and it is probably cheaper to sow and plant without waiting for natural regeneration as the cost of weeding is greatly reduced. Nursery work has improved enormously during the past few years and the writers believe that, with a well-planned sowing and planting programme, including advance nurseries for areas likely to prove stubborn, much can be done to keep regeneration from getting behind hand. Above all it is essential to keep a running account of the progress of regeneration.

Conclusion.—The writers consider that sufficient experience of the "Punjab" Shelterwood system has been gained to show that it is likely to afford the best silvicultural treatment for the majority of the Himalayan coniferous forests situated on terrain suitable for the concentration of regeneration in definite blocks. In regeneration areas, by allowing the retention of pole crops and by treating selection type on selection lines, it obviates the chief disadvantages of the shelterwood compartment system; by maintaining a considerable degree of uniformity in the crops it

retains the advantages of that system. By enabling removal to be followed by replacement with a fair degree of certainty, it has overcome the very serious disadvantage of the selection system, while it permits marking to be made so as to afford protection to the hillsides to the extent necessary. In order to facilitate the operation of the Punjab Shelterwood system, and to avoid possible breakdowns in the future, the following suggestions are submitted :—

1. In cases of appreciable reduction of capital by fire the yield be proportionately reduced. This is considered a *sine qua non* whatever method of management.

2. For working circle in which more than one species have to be controlled, a combined yield should be prescribed.

3. Where practicable, a 3 years felling programme be prepared annually.

4. Where a heavy periodic increment is expected to occur in P. B. I., this should be taken into account after short intervals, say 10 years.

5. Greater elasticity should be afforded to the executive by adopting one or other of the following expediencies, according to circumstances :—

A. A large or more flexible regeneration period.

B. An alternative optional yield.

C. Final yield from P. B. I. and other blocks to be combined, but that of the latter to be reserved against contingencies, if necessary.

6. Strict control of the progress of regeneration by means of periodic assessments.

7. The yield should be calculated in terms of the volume of merchantable timber actually available, ignoring increment, and considerable latitude allowed to the executive to fell it as and when required.

8. Where a plan prescribes the felling of final yield outside P. B. I., the working plan officers' estimate of the yield available from each compartment should be given in the plan, and these figures should also appear, as estimates, in the control forms.

9. Management should take full account of grazing requirements.

10. Whenever practicable, the author of the working plan should be consulted when difficulties appear to be such that an interim revision is demanded.

(*Punjab Forest Conference Proceedings.*)

A. P. F. Hamilton, *D. C. F.*

N. C. Pring, *D. C. F.*

His Majesty

INDIAN FORESTER

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THE JUBBAL STATE FORESTS

By H. M. Glover, I.F.S.

Introduction

The Simla Hill States extend from the borders of Tibet to the foot-hills of the Himalayas, cover an area approximately equal to that of Wales, and are under the political control of the Punjab Government, but will shortly be transferred to the Government of India.

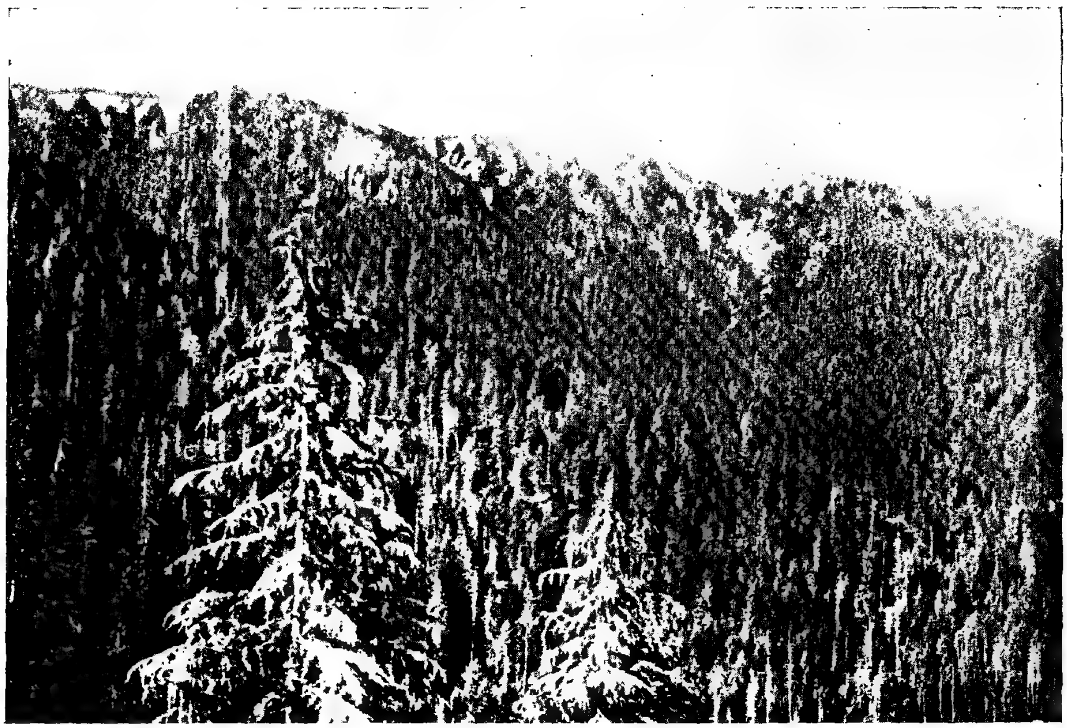
The tract is mountainous in the extreme and is traversed by the Great Himalayan range rising to heights of 22,000 feet at Leo Porgyl on the borders of Tibet, by the Dhaola Dhar whose lowest passes are over 15,000 feet in altitude, and by the numerous sub-ranges of the Outer Himalaya which lie between the Sutlej and Jumna rivers. The Punjab, the United Provinces, the Patiala, Bikanir and Bahawalpur States are vitally interested in the preservation of the catchment areas of these great rivers, as from them debouch the Eastern and Western Jumna, the Sirhind and the Sutlej canals, which irrigate lands of the Gangetic and Punjab plains in which lie many hundred thousand acres of the most fertile fields of India.

Before the beginning of the nineteenth century, the country had been ruled by numerous Chiefs of whom the most important were Tehri-Garhwal, Bashahr, Bilaspur and Sirmur: smaller chieftains made alliances with the more powerful States, and maintained themselves by force of arms, hidden behind their forests and assisted by the lack of communications and the inhospitable nature of the country. At the end of the eighteenth century the Gurkhas spread from Nepal westwards along the Himalayas as far as the Sutlej, subjugating the Native Rajas, occupying the country and levying

tribute from such of the Chiefs as they did not eject. The British Government broke the power of the Gurkhas in 1817, and handed over the States to their original owners as a reward for their assistance in the War. The boundaries of the States were determined and the Jubbal State occupied its present limits, forming a compact area of 288 square miles of which less than one-tenth was cultivated.

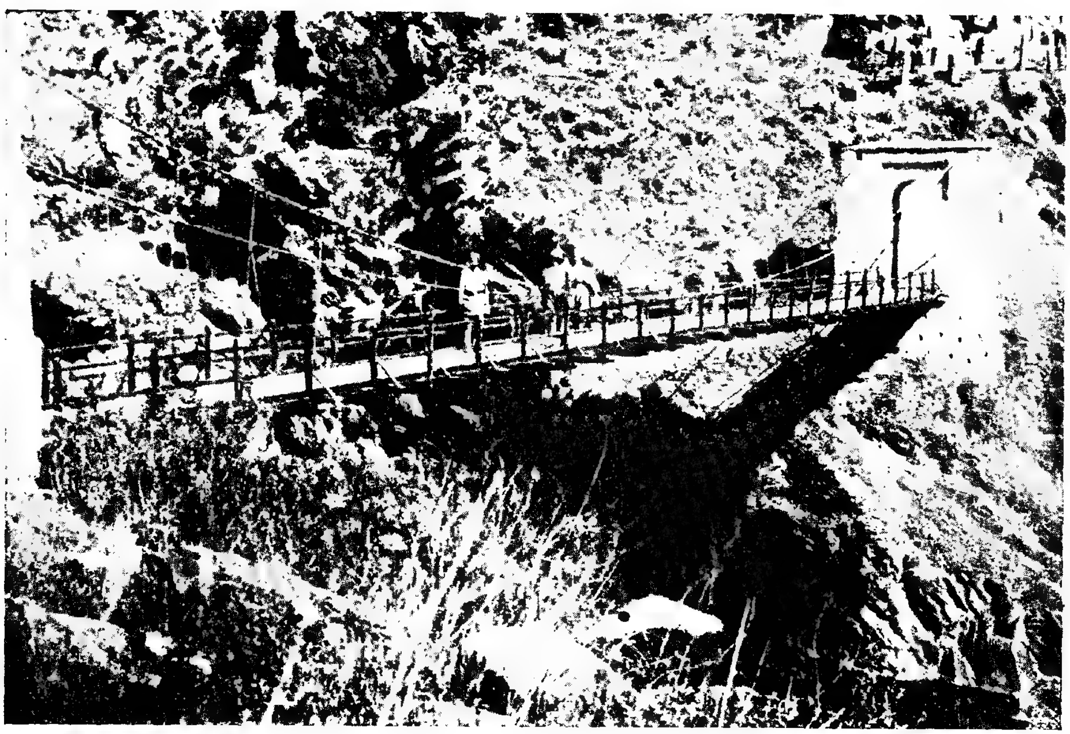
Cantonments were established in the Outer Himalayas and a start was made in building Simla, which eventually became the summer residence of the Government of India and the Punjab Government -Timber and firewood were obtained from neighbouring States; contractors went throughout the Himalayas buying whatever trees they hoped to extract at a profit, felling whole forests, and as the more accessible forests were exploited moving on to those more remote. The villagers then burnt the cut-over forests, cultivated the lands for a few years until they became exhausted of their fertility and lay waste, and burnt as much forests as possible in order to form grazing grounds for their increasing flocks and herds. Formerly it had been unsafe for flocks to migrate from one State to another as the animals were raided *en route*; but gradually the flocks which, during the summer, grazed the high lying Alpine pastures of the great Himalayan range and the Dhaola Dhar came down in the winter to the tracts bordering the plains, while nomadic Gujar herdsmen of the Sub-Himalayan tract migrated to the higher lying forests and Alpine pastures in order to graze their buffaloes during the summer.

By 1851, the disappearance of the forests from the neighbourhood of Simla, increasing difficulties in the matter of timber and firewood supply of the cantonments, and extensive forest fires which often lasted for weeks on end led the Government of India and the Punjab Government to take an interest in the preservation of the forests. At first attempts were made by the Superintendent of the Simla Hill States to induce the Chiefs to abandon wholesale cutting of trees and to prevent conflagrations; but to his exhortations the Chiefs paid little heed. Certain officers, notably Mr. W. Coldstream, interested themselves in forest conservancy, but soon realised that



Fir forests below the Chur Peak.

Jubbal State. April 1934.



Suspension bridge built with old wire ropeway ropes.

Jubbal State. 1934.

they did not possess the technical knowledge of forest management requisite to ensure success.

Advantage was taken of the formation of the Forest Department in British India to obtain reports on the constitution and management of the forests, but it was realised that there was no hope of success or permanent effect unless a Forest Officer was appointed as assistant in forest matters to the Superintendent, Simla Hill States. An Imperial Forest Officer, Mr. A. L. McIntire was appointed as forest advisor and assistant in 1888, and it is due to the tact and efficiency of this officer and his successors, who were responsible to the Conservator for the soundness of their technical advice but were not subject to his direct control, that forest management has obtained a secure footing in the Simla Hill States. The Rajas, one and all, now recognise the value of forest protection and its pecuniary benefits, but only rarely is it found that the more enlightened Chiefs are prepared to forego immediate revenue from trees cut when they first attain marketable dimensions long before they become mature. Of all Chiefs the present ruler of Jubbal, Raja-Rana Bhagat Chand, C.S.I., has shown the greatest appreciation of the benefits of forest conservancy and the advantage to himself and his successors of a regular income not subject to excessive fluctuations.

With this short introduction to the general history of forest management in the Simla Hill States as a whole, we must be content, and we will now proceed to consider in more detail the history and progress of forest management in the Jubbal State

Forest Management in the Jubbal State

Physical geography and geology.

The Jubbal State lies in the Inner Himalayas at a distance, as the crow flies, of about twenty miles east of Simla. A long ridge runs from Kupur to the Chur peak, altitude 11,992 feet. The forests lie on the slopes of this ridge and on subsidiary spurs between the Giri, Pabar and Tons rivers, the last of which leaves the State at an altitude of 2,300 feet.

The geology of the tract is interesting as influencing the distribution of the various species of trees. On the main ridge and the Chur peak the rocks consist of granite, gneiss and metamorphosed

crystalline rocks overlying mica schists and bands of quartzite and argillaceous schists pierced by veins of quartz. These latter appear to be metamorphosed sedimentary rocks which have lost all trace of their original structure owing to the great strains, pressure and heat to which they were subjected when the Himalayas were formed. A few bands of limestone and of ferruginous sands are found at lower altitudes, the latter having been smelted for iron before the local product was ousted by imported metal. The soil from the granites, gneisses, crystalline rocks and quartzites is a sandy loam, and that from mica schists is a clayey loam ; on the former deodar flourishes ; on the latter the kail ousts the deodar ; on the quartzites at low elevations chir regenerates with ease.

The topography of the country is influenced by the hardness of the rocks and their differential weathering when exposed to atmospheric and meteorological influences, the elevated ridges having survived as a result of the hardness of their component rocks. Within the forest belt the average slope varies between 30 and 35 degrees as a rule, and the rocks dip generally towards the north-west ; on southern outcrops, however, and in the Giri catchment area, the slopes are occasionally precipitous, and below the forest belt they are often very steep. The streams are perennial and most are of easy gradient and are well suited to the floating of timber in the form of scantlings, but are too shallow to carry logs.

The climate.

The climate is described as being similar to that of Simla. This is not strictly true, as the rainfall varies directly with elevation; moreover much rain is precipitated on the outer slopes of the Chur, on which S. W. monsoon impinges and does not reach the valleys sheltered by that mountain. The annual rainfall, from an analogy with neighbouring tracts, probably lies in the neighbourhood of 30 inches at low elevations ; 45 inches at from 6,000 to 8,000 feet within the deodar belt ; 75 to 80 inches above 9,000 feet elevation, while at least half the rain falls during the months of July, August and September. The summer months of April to June are hot and dry, the autumn is dry, and during the winter snow falls but soon melts at elevations below 7,000 feet.

Area.

The following statement shows the approximate area of the State, its forests, cultivated lands and pastures :—

		Acres
Forest	..	93,000
Cultivated lands	..	18,600
Pasture lands, etc.	..	72,720
Total area of Jubbal State		184,320

General description of the forests.

The forests contain the usual species found in the Punjab Himalaya : the *kharshu* oak (*Quercus semecarpifolia*) and silver fir (*Abies webbiana*) cover the highest slopes, lower down the spruce (*Picea morinda*) occurs amongst the fir, while at from 6,000 to 8,500 feet the deodar (*Cedrus deodara*) and blue pine (*Pinus excelsa*) form extensive woods mixed with spruce and silver fir at their upper limits and on the cooler slopes, and with scattered broad-leaved trees, such as the *mohru* and *ban* oaks (*Quercus dilatata and incana*) bird cherry, maples, horse chestnut, etc. At low elevations the *chir* (*Pinus longifolia*) grows in pure crops.

The oak, silver fir and spruce forests are virgin ; the deodar and blue pine forests have been worked since about 1880 ; the *chir* pine forests have been gone over in shelterwood fellings in the last twenty years, and, where reasonably protected from fire, are well regenerated.

The demarcated forests consist of 68,000 acres of approximately the following constitution :—

		Acres.
Pure deodar	..	3,600
Mixed deodar and blue pine	..	5,600
Mixed deodar and spruce	..	20,000
Blue pine	..	7,700
Chir pine	..	1,000
Fir and oak	..	25,600
Blanks and plantations	..	4,500

In addition there are 17,000 acres of *dehat* or village forests, well stocked with deodar, blue pine and *chir*, the revenues from which the

present Raja has placed in a trust fund from which is to be met expenditure on public works, such as hospitals and schools, for the benefit of his subjects

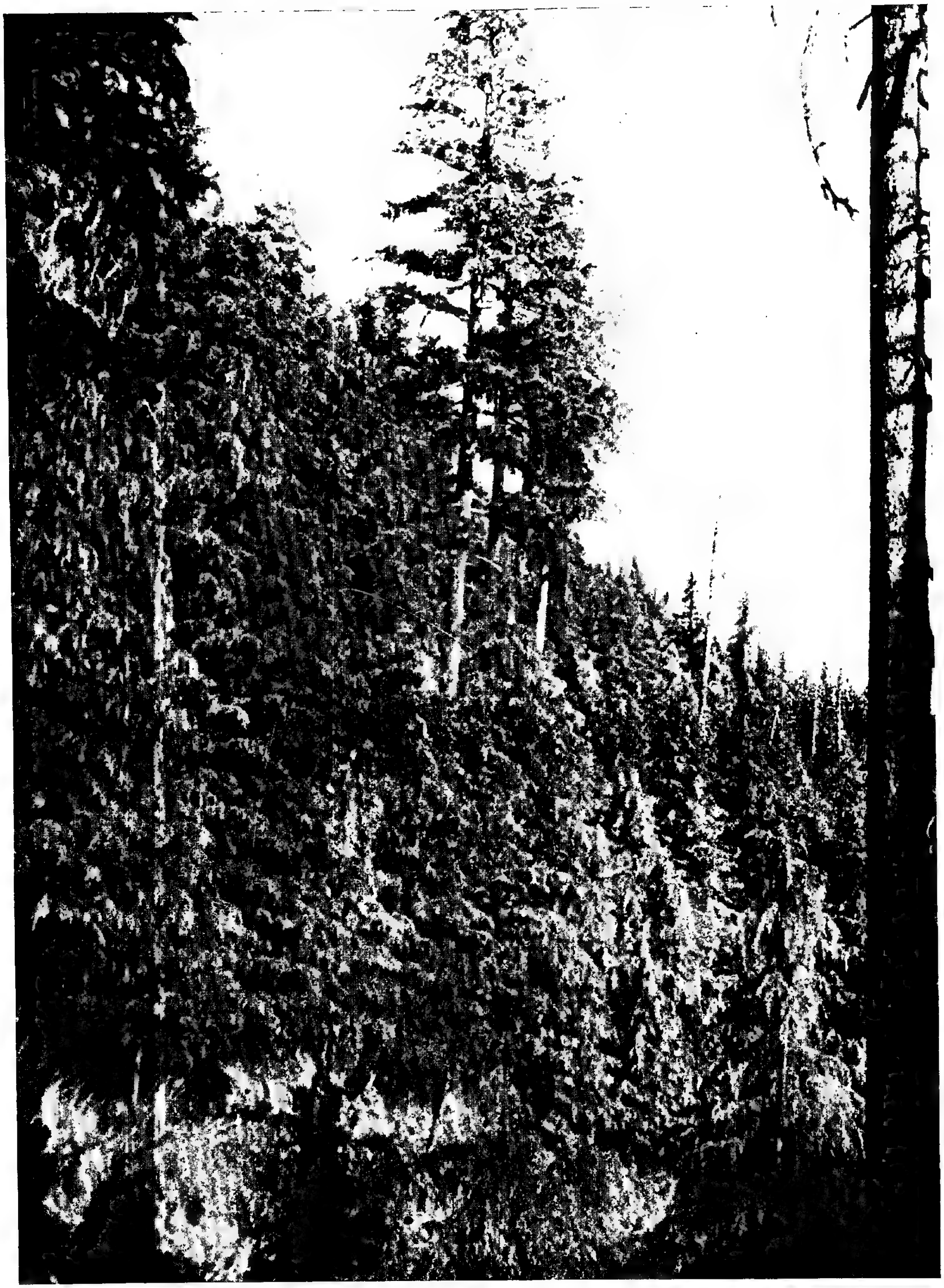
In this note we shall discuss only the conditions prevailing in and the management of demarcated forests in which deodar and blue pine form the major portion of the crop. These woods are well regenerated, the valuable deodar is favoured artificially against the aggressive blue pine, and both species are encouraged at the expense of the silver fir and spruce.

Early history.

The forests were at first considered to be unworkable as it was impossible to extract timber in the form of logs, while the streams were considered to be too shallow and their beds to be too steep and rough to permit of the extraction of sawn scantlings. Previous to 1880 no timber had been exported from the State. Government had in fact contemplated taking a lease of the forests but considered that the difficulties inherent in working them were such as to deter private traders, and finally was satisfied with urging the Rana to make proper arrangements for conserving his forests. The difficulties of extraction had been much exaggerated and contractors worked the more accessible portions of nearly every forest. From 1884 to 1888 the State was allowed to treat its forests as it liked, and large sales of deodar and blue pine trees were made. The forests from which timber had been cut were burnt and broken up for cultivation, and to this day numbers of large stumps are seen near Deya below pole forest which dates from this period, while scars on trees show that most of the forests were burnt at one time or another.

Forest conservancy commenced in 1888 with the appointment of Mr. McIntire, Assistant Conservator of Forests, to assist the Superintendent, Hill States, in forest matters and in giving effect to instructions issued by the Punjab Government regarding the forests of the Simla Hill States.

The Superintendent, Hill States' instructions were, however, continually disregarded until 1897 when a Forest Ranger was placed in charge of the Jubbal State forests,



Natural deodar and kail regeneration on the way to Deya.

Jubbal State. *April* 1934.

In 1900, Mr. E. M. Coventry, drew up a working plan for 24 years on the Selection system which prescribed the felling of 2,000 I class deodar over $2\frac{1}{2}$ feet diameter and 2,000 I class blue pine in the main felling series.

The 1900 Working Plan.

The stock enumerated was :—

		Deodar	Blue pine
over $2\frac{1}{2}'$ diameter	..	66,000	48,000
from $2'$ to $2\frac{1}{2}'$,,	..	70,000	60,000
from $1\frac{1}{2}'$ to $2'$,,	..	83,000	85,000
from $1'$ to $1\frac{1}{2}'$,,	..	109,000	100,000

It will at once be seen that the yields of deodar and blue pine were fixed at very low figures, the reasons being three, *viz* : (*a*) the mature deodar trees were often scattered through dense fir forest and could not be cut without turning the forest into valueless fir ; (*b*) there was a shortage of middle aged deodar trees which could develop into first class size ; (*c*) there was only a poor demand for blue pine. It is entirely due to this conservative realisation of the yield of mature timber that the forests were exceptionally well stocked when handed over to the Raja for management in 1915, and the present Raja owes a debt of gratitude to Coventry and to the long sighted action of the Punjab Government for securing a valuable heritage in the present forest estate.

In 1915 the Raja assumed full charge of his forests, but obtained the services of Punjab Government Forest Rangers and a retired Provincial Service Officer for their management. Sir George Hart, Inspector-General of Forests, visited the State in 1920 and commented most favourably on the general improvement in the condition of the forests, on their management, and on the interest taken by the Raja in forest affairs. 1921 was a year of drought and of political unrest, and a large portion of the State was ravaged by fire ; the most valuable forests were fortunately saved by the devoted efforts of the Staff and of the villagers, otherwise the damage would have been such as to overwhelm the State with financial disaster. The yield, however, from 1915 onwards increased

Period 1915 to 1924.

greatly, and in 1924 the Working Plan Officer was of opinion that the number of blue pine trees cut in improvement fellings was in excess of that prescribed in the working plan, and that the probable reason was the removal of trees killed by fire ; also that many healthy middle aged deodar had been removed merely because they stood over regeneration, and that trees which would have formed part of the future yield had been cut.

The 1924 Working Plan.

In 1924 Mr. Jhunna Singh, Assistant Conservator of Forests, prepared a working plan, as Coventry's plan had expired, according to instructions issued by Mr. A. J. Gibson, Conservator of Forests. The Selection system was abandoned, except for forests on very steep and precipitous ground : the plan followed the general lines of the Shelterwood, or Regular, system of management.

The yield consisted of the volume of all deodar and blue pine over 12″ in diameter in P. B. I : in addition certain fellings of both mature and immature trees were permitted without volume control outside P. B. I. The plan was passed by the Chief Conservator, but under his orders the writer, in 1926, examined the prescriptions of the plan and their effect on the permanency of the yield. It may here be noted that the main demand is for B. G. sleepers and for scantlings of large cross section, small timber commanding either a very poor price in the market or being valueless. Consequently the combination of the volume of small trees and large trees in one figure for purposes of control permitted both an unduly rapid realisation of the mature stock and the unnecessary cutting of immature trees. From the 1925-26 control forms it was seen that the prescriptions were being exceeded. In other words the capital of the forests as represented by the stock of mature and semi-mature trees was being rapidly depleted. In 1927 the prescriptions were revised, and the Raja, who had himself called the attention of the Chief Conservator to the excess fellings, willingly accepted the modifications and the reduced yields suggested by the Chief Conservator.

The 1927 modifications to the Working Plan.

In 1927 the following orders were issued modifying the prescriptions of the 1924 working plan :—

(*a*) In P. B. I well grown groups of immature trees were to be retained.

(*b*) In P. B. II the stock of timber was to be maintained intact in order to safeguard the future yield.

(*c*) In P. B. III all mature deodar were to be retained.

(*d*) In P. B. IV all deodar below 27″ diameter, apart from trees cut in thinnings, and all sound blue pine below 24″ diameter, apart from trees cut in thinnings or when standing over groups of valuable deodar saplings or poles, were to be retained.

The object of the changes was to conserve immature stock and to prevent a very large drop in the yield after 25 years. The changes were gladly accepted by the Raja, and it is not an exaggeration to say that had they not been made the volume felled to date would have been so great as to prejudice for a generation the future revenues of the State.

Some notes on the present condition of the forests.

The forests were inspected by the writer in 1934, and some notes on their condition and on the results of management will be of interest.

In P. B. I regeneration fellings have been very well done and there is abundant natural regeneration, much of it dating from before 1924. Groups of immature trees have, for the most part, been left to form part of the future crop and have been properly thinned, and will be retained until the plan is revised as they will put on rapid volume and valuable price increment. It is certain that at the revision of the working plan less stress will be placed on regularity, and that in future the lines followed will be those of the Punjab Shelterwood system. Some of the forests lie on very steep ground and are being transferred to the Selection Circle, their place in the Regular Circle being taken by mixed fir and deodar forests, transferred from the Unregulated Circle. The technique of regenerating mixed fir and deodar woods is well understood by the staff, and

already heavy shelterwood fellings bearing on the fir have been made.

The fires of 1921 left many scars on the hill sides, and in 1926 a start was made in restocking them by burning the refuse and sowing deodar seed with excellent results over very large areas.

The forests generally are in excellent silvicultural order, are fully stocked apart from the areas destroyed in the 1921 fires, most of which have been re-planted with deodar ; they have been properly thinned and compare favourably with any forests in British India or in other States. Deodar is rapidly extending, thanks to its marvellous reproductive powers in these forests where conditions are eminently suited to its growth, and to improvement fellings which have favoured it against blue pine and the firs.

Most of the young woods have been thinned, but as it has been found to be impossible to dispose of the outturn there is much inflammable dead wood which will constitute a danger from fire until it rots. There appears to be no remedy for this state of affairs, and thinnings amongst unsaleable trees have had to be abandoned.

Mention must be made of the excellent bridle paths, which are well aligned and built and could scarcely be improved upon. The cost since 1924 has been Rs. 1,12,500. The main system of communications has been completed and the State will now make narrow footpaths along the contours for ensuring mobility of a labour force when engaged in fire protection, for inspection, and for sub-division of large compartments. Comfortable rest houses and subordinates' quarters have been built at many places. This progress has been rendered possible by the large profits, somewhat swollen by the revenue from the heavy fellings at the beginning of the period, which have accrued from the working of the forests : for the last ten years the surplus has averaged Rs. 5,20,000, or Rs. 10 per acre of merchantable forest.

The writer would like to record his high appreciation of the example which Raja-Rana Bhagat Chand is setting to other Rulers in the management of his forest estate, which is of particular value at the present time of transition, and also of the high technical

qualifications and capacity possessed by his Superintendent of Forests, Mian Lakshmi Singh.

The effect throughout the Simla Hills of proper forest management in Jubbal cannot well be over-estimated, and it is satisfactory to be able to quote the Jubbal State as an example of what the Punjab Government hoped to attain when it first took steps to ensure that better forestry should be practised in the Himalayas. Raja-Rana Bhagat Chand celebrates his Silver Jubilee as this article approaches its completion, and the writer offers him his best congratulations on a successful and enlightened rule extending over a quarter of a century, and wishes him, his State and his forests, all prosperity in the future.

BRIDGE BUILT BY BALAGHAT FOREST SCHOOL STUDENTS

BY A. C. HOPKINS, I.F.S., D. C. FORESTS, C.P.,

Director, Balaghat Forest School.

The bridge shown in the accompanying photograph (Plate No. 51) was built by the students of the Balaghat Forest School in March-April this year. It spans the Katang Nala in the Pandratola Block, Lamta Range of the Balaghat Division which was previously crossed by a temporary bridge which had to be rebuilt every year.

Owing to the heavy floods which occur annually in this vicinity, and to the nature of the nala bed which is sand overlying alluvial mud of unknown depth, it was decided that piers anywhere in the centre of the nala would present too many difficulties and the bridge was designed to consist of a central span of 33 feet and two side spans of 16½ feet each.

The old crossing was found unsuitable and a new site was selected some two furlongs upstream. This necessitated a diversion of the road to the new crossing, and just over 11 furlongs of new road were aligned and constructed. Practically the whole of the work on the bridge itself, and the road work, both alignment, clearing and construction, was done by the students themselves.

The following timbers were used in the construction of the bridge :—

(*i*) *Koha* (*Terminalia arjuna*) for the piers, abutments and short girders of the side spans ;

(*ii*) Teak for the long girders of the central span and their trusses ;

(*iii*) *Tinsa* (*Ougeinia dalbergioides*) for struts ;

(*iv*) Sal.—Rejected sleepers from the Lamta Depot for paving the roadway over the girders, and for railings.

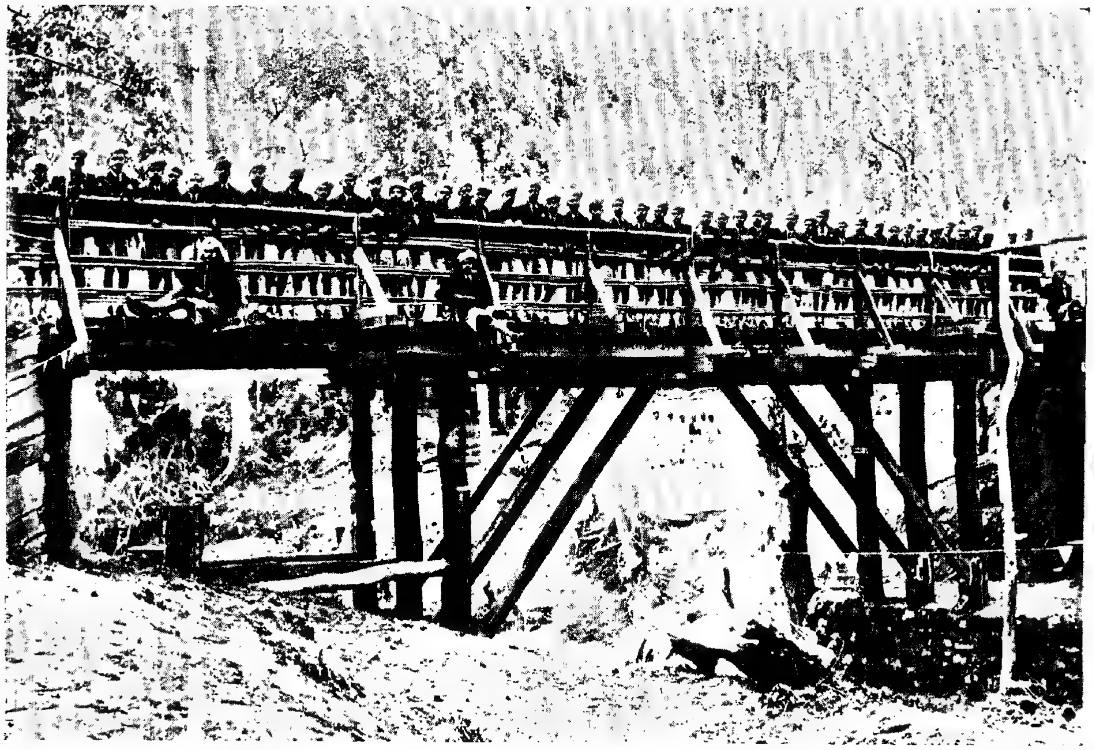
The first three species are all found in this locality. *Koha* was felled actually on the site of the bridge, and teak and *tinsa* were obtained from the clearing of the line for the new road.

The greatest difficulty in the construction was presented by the erection of the piers. These were essential to support the struts of the bridge, the nala banks being black cotton soil. The foundation was 3 feet of sand over alluvial mud, the whole saturated with water, and the plan adopted was to sink into this large wooden frames 9½ feet long by 3½ feet wide by 6 feet deep made of 1½ inch planks sawn from rejected sleepers. On account of a small stream flowing through the nala it had to be dammed 100 yards upstream before the frames could be sunk.

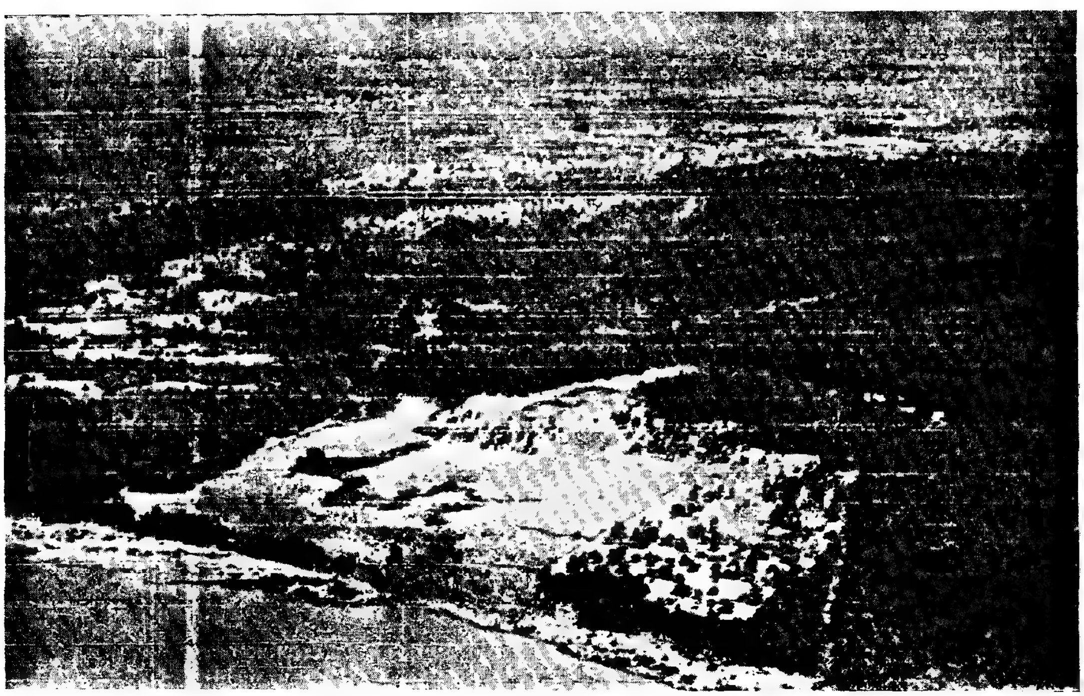
Into the rectangular pits formed by the sinking of these frames into the nala bed, slabs of *koha* timber 8½ ft. × 2½ ft. × 1 ft., were laid to form foundations for the three piles forming each pier, and to prevent uneven sinking.

The total length of the bridge is 66 feet and the height above the nala bed 33 feet.

The small plates attached to the girders were placed there by students, each of whom engraved his name and Division or State as a record of the work he had done on the bridge.



Bridge built by Balaghat Forest School students.



Aerial Reconnaissance of Forests of Madras.

AERIAL RECONNAISSANCE IN THE FORESTS OF MADRAS

BY C. C. WILSON,

Conservator of Forests, Madras

The forests of the Upper Godavari Division cover some 890 square miles and are largely inaccessible, the main line of export being by the river after which they are named, so that anything which cannot be transported cheaply to the waterways cannot be extracted at a profit.

2. Consequently the hinterlands have received little attention up-to-date and there is not much known about them.

3. The forests are inhabited by a primitive race of lazy little savages known as Koyas, who can be very troublesome if disaffected; they gave an example of this in 1922-23 when the "Fituri" raged for many months, with considerable loss of life. As these aborigines dislike work of any sort it is difficult to open up the forests, and this again accounts for their backward condition.

4. A further brake on development exists in the seriously unhealthy conditions that prevail; the last big party that endeavoured to make a comprehensive reconnaissance of these forests was led by Mr. Cowley Brown in 1900-01. He reported as follows:—

"A particularly deadly malaria is associated with this part of the country........Nearly everyone of the party of about 25 that was engaged in inspecting this forest preparatory to the compilation of this Plan subsequently suffered severely from low fever of a malignant and lingering type. Two servants, three peons and the mahout died, two of the other menial subordinates are now dangerously ill, and the Working Plans Officer, owing to a severe attack of dysentery was compelled to take sick leave at first for three months and subsequently to Europe for six months more. Twenty-five per cent. of the party are already dead."

5. Nevertheless in their due turn the forests of this division had to be put under working plan, and for that purpose a reconnaissance was essential.

6. In October last when I had hoped to attend the Silvicultural Conference at Dehra Dun the party from South India proposed to

make the toilsome journey by aeroplane, and it was on hearing of this that the Working Plan Officer of Upper Godavari, Mr. Banerjee, asked me whether it would not be possible to make a detour by air in order to inspect the Godavari forests and so find out if sufficient could be seen in this manner to be of value.

7. The proposal to fly to Dehra Dun fell through, for various reasons, but the germ of the idea was there, and in January when the writer was considering how best he could get a general idea of the forests in question the proposal to do so from the air recurred to him.

8. No aeroplane was available which was fitted for the work with the necessary camera and other apparatus, but it was found that a good plane could be hired from the Madras Flying Club at a reasonable rate, and that there was a pilot ready to make the flight over this unknown country.

9. The Working Plan Officer was communicated with by wire and asked whether he could prepare a landing ground at Bhadrachalam and whether he could corner sufficient petrol to ensure a safe return.

10. His reply being satisfactory on the second point arrangements were made for the aeroplane to fly up from Madras to land at Gannavaram on the 25th of February, this place being within eighty miles or so of the Godavari forests, so that it would be possible to make the reconnaissance from this place should the landing facilities in Bhadrachalam prove unsuitable; and the Working Plan Officer was instructed to meet us at Gannavaram.

11. The morning before the aeroplane was to arrive my wife and I inspected the landing ground, and, finding it covered with large white-ant heaps, we arranged to have them levelled; though ignorant of such matters it seemed commonsense to us that they would be definitely in the way. It was fortunate that we took this precaution as, otherwise, the pilot nonchalantly told us, he would certainly have crashed on landing! It may be mentioned that this landing ground was an old one which had not been used for some time.

12. The Working Plan Officer arrived the same day and brought with him a diagram of such landing ground as he had been able to

make at Bhadrachalam. This was some 500 yards long and 200 yards wide, with a bund across it about two-thirds of the way up, which had been levelled off. Our pilot, Mr. Everret, felt confident that landing on this ground would present no difficulties, and we, therefore, sent on our kit by train and left the next morning by aeroplane for Bhadrachalam.

13. We covered the 80 miles in approximately three-quarters of an hour without incident, and landed safely on Mr. Banerjee's improvised ground, though the fact that the bund had not been sufficiently levelled nearly resulted in our propeller striking the ground. Owing to the skill of the pilot, however, this was averted, and before taking off again for the actual reconnaissance of the forest, which we proposed to carry out that same afternoon, full instructions were given to the local subordinates to have the bund completely obliterated.

14. This was the first occasion on which an aeroplane had landed at Bhadrachalam, and it excited great interest. It was only with the help of the police, who gave us every assistance, that the local populace, including a number of Koyas and Reddis, could be induced to keep at a safe distance when we were landing and taking off.

15. At 2-45, of the same day, we took off for the Nugur Range. Here the forests lie mainly on a plateau broken up into valleys and ridges, without roads or bridle-paths and containing, according to report, mainly grass and a poor type of timber forest. I had had the appropriate 1″ Survey of India sheets cut and mounted in one long strip with a wooden roller at each end, so that, as our flight progressed, the map could be rolled from one roller to the other and so conveniently consulted. On this the direction of flight had been marked with red pencil, and so a course was set which the pilot found easy to follow. We traversed the forests from end to end four times, flying at heights varying from about three hundred to a thousand feet, and found we could get a clear view of the forests below us in which even the species were often recognisable.

The method of recording adopted was for each observer to have a pad marked out in 2 minute intervals, on which notes were made of the type of forest immediately below and to each side of the 'plane, and of the points at which photographs were taken ; the notes were serially numbered, and the positions were roughly marked on the map with reference to local features ; this was easy as the Godavari river was nearly always visible, and other rivers, streams and mountains could be readily recognised. With the aeroplane flying at a known and constant speed, and the observers' watches synchronised beforehand, these records made it possible to get an excellent general idea of the forests.

I took a number of photographs with a ¼ plate hand camera, as well as with a Leitz Leica, using 35 mm. cinema film ; not much was expected from the results as the lower plane of the bi-plane in which we were flying got in the way, and, it being necessary to take the photographs at an angle, instead of perpendicularly, consecutive pictures could not be made to coincide. However, it was hoped, that sufficiently accurate photos of the forest could be obtained to assist in the preparation of stockmaps, and this was found to be the case with the pictures produced by the miniature camera an enlargement of one of which is reproduced (plate 51); those taken with the ¼ plate have not yet been printed. The forest consisted mainly, as expected, of a degraded type of deciduous timber forest with much high grass and it was obvious that the whole had been submitted to repeated annual fires for many generations. Occasional pockets of good bamboo or timber forest were marked and these were recorded on the map for future examination. The air conditions over this broken and hilly country were rough and all three observers, my wife, myself and the Working Plan Officer were air-sick, but this was not allowed to interfere with the progress of the work. We returned to Bhadrachalam and made a safe landing by 5 o'clock ; that evening, having completed the reconnaissance of one half of the forest.

16. Next morning at 11 A.M. we started again and flew westwards to reconnoitre the forest of the Rekapalli Hills and Maraguda Reserves. Again a map had been mounted on rollers,

in a similar way to that used on the previous day, and a course set. Unfortunately the pilot lost his map which was blown overboard in a high wind ; however by means of the speaking tube I was able to direct him and we succeeded in flying over approximately the course laid out on the previous evening.

17. Again it was possible to see the forest clearly to distinguish the more important species such as teak, *Terminalia tomentosa*, bamboo, *Chloroxylon swietenia* and a few others. The terrain was even more broken and precipitous than it had been on the previous day, but the air conditions were less bumpy, so that we were not inconvenienced by sickness. On this occasion Ranger Appa Rao made one of the party as an additional observer.

18. Though not so devastated by fire as the forests of Nugur these jungles also proved to be of little value. Again a few pockets of timber of sufficient value to make exploitation advisable and of good bamboo, were marked for further examination on foot ; but by far the greater part of the area examined proved to be of no value.

19. From the 'plane, on both days, as we passed over little jungle villages we could see the Koyas running terrified to their huts and diving through the doorways into comparative safety. During my subsequent tour on foot I explained in several of these villages what had been happening, and the villagers told me that their forbears had, originally, many many years ago, been brought from far away by great birds and dropped into these jungles, and they were convinced, when they heard the roar of our engines and saw the aeroplanes circling overhead, that the same birds had returned to carry them off again.

20. The actual cost of the aerial reconnaissance including the photography amounted to some six hundred rupees, and had the work been done by ordinary reconnoitring parties it would have taken eight of them at least five months to complete at a cost of between three and four thousand rupees, and probably several lives.

21. The fact that the conclusions arrived at were largely negative does not detract from the value of the work done, as in any case, the whole of the reserves would have had, of necessity, to be reconnoitred. And the results show that an aerial reconnaissance of

unknown forests, similar to those of the Upper Godavari, is a cheap and effective method of arriving at their possibilities. Admittedly accurate surveys cannot be carried out by such methods unless special photographic apparatus is fitted for the purpose, which would entail heavy expenditure ; but this was not required in the present circumstances and the aeroplane, as a reconnoitring machine pure and simple, was found to be cheap and effective.

PROTECTION FORESTS AS A MEANS OF PREVENTING DESICCATION

By R. Maclagan Gorrie, d.sc., i.f.s.

Two proposals have recently been mooted for the creation or conservation of large areas of forest with the primary object of checking or modifying an obvious increase in aridity. Recent desiccation of farm lands on a scale which cannot be attributed entirely to climatic changes has occurred in places so far apart as West Africa and the Middle West of the United States, and in each case afforestation, or conservation of existing forests, has been suggested as a practical remedy. These proposals should be of very vital interest to any forester who takes a pride in keeping his professional knowledge up-to-date, for it is in the local application of a few simple and widely applicable biological rules that our professional skill as foresters can best be demonstrated.

I. The West African Problem

Professor Stebbing of Edinburgh recently made an extensive tour in Africa, crossing the Sahara from south to north after visiting several of the British and French territories of West Africa. From his own observations and from his discussions with British and French officials he has formed a most gloomy view of the encroachments now taking place and the threat of further losses from the spread of sand southwards through the populous territories between Lake Chad and the Ivory Coast. ("The Encroaching Sahara ; a

threat to the West African colonies ; " a paper read to the Royal Geographical Society by Prof. E. P. Stebbing, and printed with a report of the subsequent discussion in *Geog., Jur.*, June 1935).

There is historical proof that this advance of shifting sands has been going on for several centuries, and there are doubtless some who emphasise it as an inevitable climatic change. More and more people, however, are beginning to recognise that such alterations are largely brought about by man's misuse of the land's natural resources. The evidence which Professor Stebbing brings forward to support this charge is certainly most convincing. Immense areas of what was originally good mixed deciduous forest, with baobab (*Adansonia*) as the principal species, have been gradually degraded by shifting cultivation. The first stage, still dependent upon the richness of the capitalised forest humus, is good farming country with scattered tall forest trees maintained for lopped fodder. The economic pressure becomes more intense when the cultivator comes to depend upon poorer second growth scrub, an acre of cultivation requiring an ever larger area of burnt forest to provide the minimum of plant food. The change in forest type which accompanies this stage is from a mixed moist deciduous forest to an open grassy savannah with scattered but still well-grown trees, and eventually the growth of this savannah type, degraded by constant cultivation plus over-grazing and burning, becomes too poor to admit of any cultivation, and a regime of nomad graziers continues the destruction by pollarding the diminishing tree growth and burning the grass. With a vast reservoir of sand a few miles to the north this is a dangerous game, and all vegetation shortly disappears under the shifting sands of the desert.

With this process going on, an increasing population is being constantly restricted and confined in a land which is rapidly becoming less capable of maintaining them. The nomadic graziers dislodged from their grazing grounds by the advancing desert, are forced southwards on top of the farming communities, and they in their turn are forced to exist for their shifting cultivation upon a diminishing and degraded forest. Shifting cultivation is the only farming method

they know, and it is probably the soundest intrinsically for their phosphorus-poor soils. The method of farming is actually less to blame for the existing state of affairs than are the huge flocks of the nomadic shepherds.

Shifting cultivation practised on a regular rotation which is long enough to allow the forest to recover fully between burnings will of course reduce the value of the forest for timber production, but will not in itself lead to desiccation of the area. If the forest is regarded simply as a green manure crop to provide a supply of agricultural manure, and is felled and burnt with this object at stated intervals, it may be in the best interests of a primitive population to allow it. But on one condition, namely, that the forest is given sufficient time to recover between burnings. This can be done only by reducing accidental fires and grazing damage and preventing any large increase in the farming population—all very well in theory, but rather a tall order for the sketchy administrative staff usually allowed for the backward tracts where such practices are common!

Heavy and uncontrolled grazing, on the other hand, will slowly but surely destroy any type of vegetation in the more arid tropics, and will effectively prevent any building up in an ecological sense of any area already in a bad condition. Once the local vegetation on the fringe of the desert has been destroyed, it is only a matter of time, and generally a pretty short time, before the sand takes possession. Once the shifting sand has come in, there is very little chance of reversing the process, and so the sand remains in permanent possession, although the rainfall may not have altered appreciably in the interval. One French administrator maintains that to the west of Lake Chad the sand has been advancing at the rate of a kilometre a year during the last three centuries. The point to be emphasised, however, is that the final and important factor is not so much the shifting cultivation in itself, but the over grazing which accompanies and follows it. To allow serious and uncontrolled grazing of the degraded savannah forest type within 30 miles of the sand frontier is nothing short of economic suicide on the part of the community which allows this.

Professor Stebbing recommends the formation of two international forest-belts running from east to west along the southern desert frontier, the first some 15 miles deep and 1,370 miles long through French Sudan, Haute Volta and Northern Nigeria to Lake Chad, in the already degraded dry deciduous forest. If this were given proper protection, he considers it could be maintained indefinitely as an arid thorn-scrub forest bulwark against further encroachment by the desert from the north. The second belt he recommends would be some 30—50 miles in depth in the better type of moist deciduous forest, considerably to the south of the first one and further from the desert; its purpose would be more or less the same as that of the American Middle West Shelterbelt, namely, to counteract the desiccation of the neighbouring farm lands and give them some meteorological protection by restoring a reasonable vegetative cover. To establish these belts will require the united action of British and French colonial governments, and will entail some very drastic form of land use planning if the eviction of a primitive population is to be effected without undue suffering and economic distress.

II. The American Middle West Problem

The proposed forest shelterbelt for the Central States has been so widely "written up" by journalists that a good many rather misleading and inaccurate accounts of it have been published.

Most of these journalistic efforts have erred on the side of exaggeration, a common mistake being to describe proposals for planting a forest belt 1,000 miles long by 100 miles broad, omitting the rather important detail that within this area it is proposed to plant up only 10 per cent. of the total, *i.e.*, 6½ million acres, not 64 millions.

This proposal was attracting much attention during my visit to the United States some months ago, and I had an opportunity of discussing it with its originator, Mr. Raphael Zon, and many other government and university foresters and botanists.

Much of the high plains country of the eleven Middle Western States has a rainfall of 14—18 inches which occurs as a few sudden

and torrential summer storms. Its natural vegetation is "bunch grass"—*i.e.*, a very incomplete turf of perennial grasses which at its best covers about 40 per cent. of the surface with its tufts. If lightly grazed, this cover is quite sufficient to prevent any excessive erosion or desiccation of the soil, but if heavily grazed, or ploughed up for agricultural crops, the loosened soil is whipped by the constant winds of the region, and is either stirred up to form shifting sand-dunes, or is carried away to fall as a dust-storm in some quite distant state. Much of this area was purely pastoral until the early 1920's when high wheat prices and a phase of wetter than average rainfall brought an influx of farmers. Enormous areas were ploughed and produced profitable wheat crops for a few years, but then followed bad prices and poorer rains, with the result that for the last 7 or 8 years the bulk of this new farming community has been "on the dole," or rather on its thinly camouflaged American substitute, "relief."

A certain amount of fairly successful shelterbelts has already been established by farmers with the help of the federal Department of Agriculture, which has a staff of foresters and several large tree nurseries for distribution of plants to farmers. The natural forests of this region are confined to poplars along the riverside flats, and there is little natural tree growth apart from these. With such a very low rainfall only well tended plantations can succeed, and there have been many disappointments, but on the other hand several thousands of farms have already been much improved in appearance, comfort, and efficiency by the belts of drought-hardy introduced trees which have been successfully raised.

The much discussed Shelterbelt Proposal is really only a further development of these farm belts, but on a considerably larger scale than has previously been attempted, with the two-fold object of providing work for those on relief and of checking the desiccation which has already reached alarming proportions throughout most of these eleven States. One important point already learnt in their plantation technique is that some intercultivation is necessary throughout the life of the trees,—ploughing between the lines at the beginning of the summer to form a deep mulch being the best means

of reducing evaporation from the ground. Another important point ; the lower the rainfall, the more vulnerable are the trees to grazing damage ; so the previous co-operative efforts have been given up and instead the government foresters are taking over on lease all ground to be planted, and putting up cattle-proof fencing, because they feel that much of this work will be wasted i' grazing at a later date is allowed to destroy the plantations or pack the soil.

The proposals have met with a good deal of criticism from certain foresters and ecologists, who feel that the money might be better spent on improving and rendering fire-proof the enormously valuable forest estate which already exists in other parts of the country. They also have qualms as to the success of forestry work under such very difficult climatic conditions, fearing that a set-back would have serious repercussions upon forestry as a whole in the mind of "the man in the street"—or rather of his American equivalent, "the average citizen." On the other hand, many practical foresters are in favour of the scheme, provided that it is accompanied by sufficient planning of other land uses to ensure that the plantations are given a fair chance, an obvious necessity being to reduce drastically both the amount of plough land and the number of live-stock.

A large area of plantations would undoubtedly help materially in anchoring the shifting soil and in providing shelter for houses and live-stock, but under such artificial conditions, as are indicated by the need for intercultivation, it is doubtful how far the forest would re-establish the underground water-table which has sunk alarmingly in the last decade. On a strictly ecological basis the best chance of economic recovery and meteorological stability for this arid tract would be to get it all under grass again, and leave only a pastoral population depending for its income upon very light grazing. Bunch grass is here the ecological climax and is the natural cover best suited to prevent wind damage and desiccation. With a large wheat-farming community already established on the land, however, it is more or less impossible to change the country into an entirely pastoral one, and whatever land use planning is undertaken must be in the nature of a compromise towards reducing the acreage of

plough land and the incidence of grazing. Combined with such a programme, there is no doubt that a network of shelterbelts maintained on a tenth of the area would do much to improve living conditions and act as a bulwark against further loss of soil by wind.

A LITTLE RED SEED : THE MALINGERER'S FRIEND

By Alyson Minchin, I.F.S.,

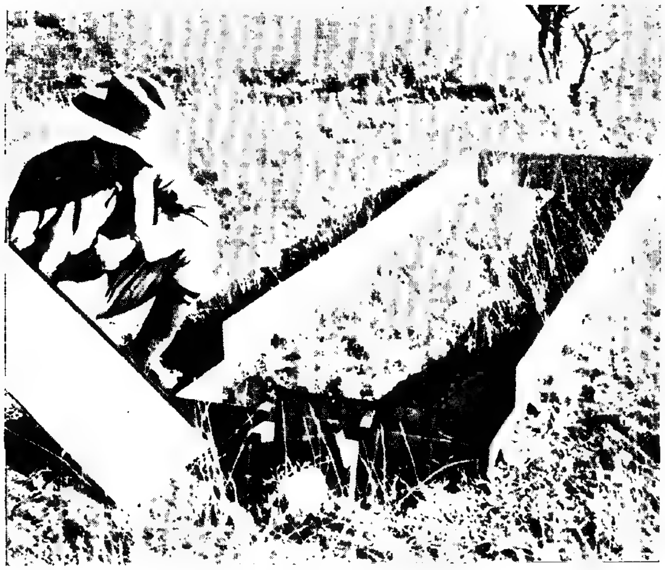
Conservator of Forests, Madras.

When the Hindu child played the jewel game with Kim, he guessed the weights in " rutees."

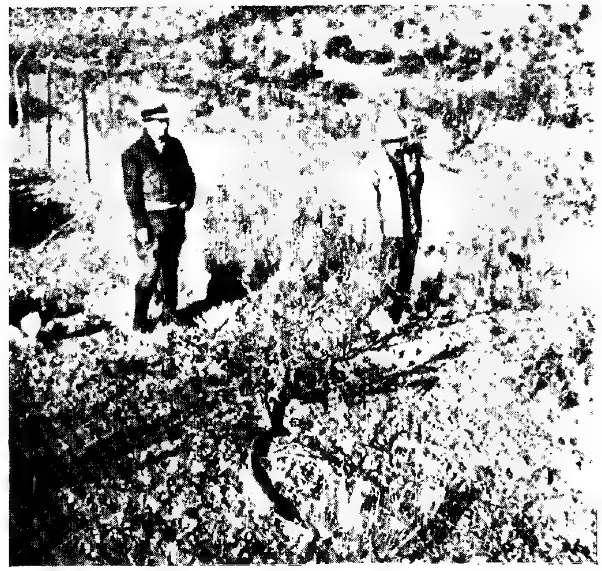
"*Rutee*" or "*rati*" is I believe the North India name for the seed of *Abrus precatorius*—' precatorius ' because it is used for rosaries. The plant is a climber, and lives in scrub jungles.

Watt's Dictionary of Economic Products says much about *Abrus*; and, as usual, should be taken not too seriously. (" Give a weaverbird a thread, or an old wife a tale—what a wonderful thing they make of it ! ") The seeds are red with a black patch at one end, and they are interesting as they are pretty. You are sure to find them in a carved sandalwood box, in the drawing room cabinet in any retired Indian Official's home in England. Children play with them on wet Sundays ; and their elders use them as counters for vicious pursuits, roulette, etc. People in India use the brown pods, with their red seeds, instead of holly for Christmas decorations.

The other day, I was in a forest in South India with a D. F. O. who is a Bengali, and an Assistant Collector, doing " forest training " —a young Mohammadan from Lucknow. We picked some seed-capsules of the creeper, and got chatting about them. The D. F. O. told us their use in the jewel trade. *Abrus* seeds do not all claim to be quite equal; but this is strange but true that any three seeds weigh as much as any three others. (We got the village jeweller to give us a demonstration that evening). The link with English weights is thus : —Two rutees equal a " carat," and a " carat " is the 24th part of an ounce, 3·16 grains. The words carat, and *rati* or *rutee* are



A simple method of testing the relative efficiency of grass and other ground cover. The rain which runs off and the soil it carries with it are caught in the end receptacle and measured for each storm.



A fenced area in the midst of a heavily grazed country will give an idea of how far recovery could be helped by closure and proper protection.

Photos : R. M. Gorrie.

The seed-pod of *Abrus*.

Photo : Vale & Co., Madras.

connected, I believe. I said my piece about the seeds. When newly picked do not give them to children to play with. Inflamed eyes, which are so common in India, are often due to children touching their eyes with their fingers after playing with *rutees*. An invisible something on the surface of the seeds affects delicate membranes.

What our Mohammadan friend told us may be known to Army doctors and N. C. Os., but it was new to me. Suppose you are a military hero but one that likes to take no part in battles ; what can you do about it ? Here is a recipe.

Soak some *rutee* seeds for 24 hours, to soften them. String them together with a needle and thread. Afterwards, pull the thread out of the seeds, and keep it for use when need arises ; it has soaked in some *Abrin* which is a powerful irritant. In good time before the Battle, get ready your doctored thread, and a needle. Make a little fold of skin on your knee, and stick the needle through and pull the cotton after it. Presently pull out the cotton. Your knee swells up ; and it is difficult even to crawl to the Doctor, with this inexplicable ailment. He cannot help putting you on the sick list.

In case the army retreats, lose no time in curing the knee ! You simply keep it in cool wet sand ; the treatment takes an hour, they say.

TEAK SEEDLINGS *VERSUS* ROOT AND SHOOT CUTTINGS

By R. I. Macalpine, I.F.S., D. C. Forests, Bengal,

Divisional Forest Officer, Chittagong Hill Tracts

Mr. W. D. M. Warren's note on this subject in the *Indian Forester* for July has been the incentive for committing to paper the subject matter of what has been something in the nature of a major controversy in this Division.

Kaptai, in the Chittagong Hill Tracts Division of Bengal, needs no introduction and much has been written on the subject of its teak plantations.

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Teak introduced in the late eighties has been the subject of immense interest in reference to planting technique, and since 1917 there is an unbroken series of plantations formed by *taungya*.

Up to 1931 the areas were regenerated by sowings of pit-treated seed sown at stake, but in the 1932 plantation this practice was abandoned for transplants from temporary nurseries. The main reasons for this departure from the method hitherto in force appear to have been economy in seed, and also regularity in the plantation. That plantations so formed were more regular than seeded plantations was obvious from the start, and infilling throughout the rains was reduced to a minimum, transplants showing few casualties; but objections arose from the *jhumias* (*taungya* cultivators) in that in the present method there was more work, and further, transplanting fitted in badly with the cultivation of crops. In the 1933 plantation the new method was continued, but in 1934 the author reverted to seed sowings.

The reasons for this retrograde (?) step should therefore be given :—

The relations between the *jhumia* and the Forest Department should, in the author's opinion, be " symbiotic " (if such a term may be used in this connection) and there is always the danger that the cultivators' interests are subordinated to those of the Department.

The *jhumia* of this District is naturally lazy and very conservative in his methods. He has been trained at Kaptai to be an excellent plantation worker and it was only fair that his objections to transplanting should be considered.

The crux of the matter was the season at which transplanting had to be done. Prior to regenerating the area a considerable amount of preparation is necessary. Timber contractors are turned into the clear felling area at the beginning of the cold weather, and, as usual in this Division, the work is carried on in such a leisurely fashion that it is a rush to get the *jhumia* to finish the cutting in time for a good burn. He is hard at it therefore at the end of the cold weather. Then the staking of the plantation has to be done—no inconsiderable

work. At the end of May the *jhumia* sows his crops and it is at this time that he must devote his whole attention to his own work, as on it depends his future welfare.

Now, in the sowings method, he sows his seed at the end of April, concurrent with staking, but in transplanting this cannot be done until the seedlings have attained a height sufficient to permit of transplanting, and this unfortunately starts just at the time that he is sowing his crops. It should be remembered, too, that prior to this he has had to prepare nurseries.

Further, under the terms of his agreement, the *jhumia* is called upon to maintain the previous year's plantation. This involves considerable labour in cleanings and is, or should be, done in June-July, just the time transplanting is being done. In practice, therefore, cleanings were extended over a long period (in many cases until September) and there was a continual tug-of-war between the Range Officer and the *jhumia* to get their respective works done.

Thus, in the author's opinion, the times for sowings fitted in better with the *jhumia's* requirements than transplanting, and as plantations formed by the former method in the past had without exception shown excellent results, the former system of direct sowing was re-adopted.

In 1933, however, the Silvicultural Division had laid out an experiment in root and shoot cuttings.

Briefly, this consisted of lines 6 feet apart with cuttings 6 feet apart in the lines Cuttings were put out at different times at approximately fortnightly intervals from the 11th April to the 9th July. Lines were duplicated.

When inspected in December 1934 results were startling. The earliest plants averaged some 7 feet in height and the latest some 13 inches. There was a definite height gradation in terms of the date of sowing.

By June 1935 this was maintained, the earlier plants then averaging some 10 feet, down to the 3 feet plants of the latest planting.

In an adjoining plot in the plantation where cuttings had been put in about the middle of May similar results were observed, the

average height in June being 10 feet. In the plantation generally, where direct sowing had been done, the average plants were 2 ft. 6 ins., but the height of individuals was very irregular, and probably blanks to the extent of 15 per cent. existed. There were no casualties in the root and shoot cutting area.

Plants of the " transplanted " plantation of 1933 were certainly not of this regularity and height at the same age.

Now, with the obvious success of root and shoot cutting can this method be universally adopted to fit in with the *jhumia's* requirements ? The experiment has shown that the operation can be done early, and therefore it will not interfere with the sowing of crops—a disadvantage as explained above of the transplanting method.

Further, in view of the rapid growth, skeleton staking will suffice thereby reducing the *jhumia's* work.

Casualties are obviously going to be less than in either of the other methods and the *jhumia* will be able to devote himself without undue expenditure of energy to other works required of him—a very important point at the present time in view of the extensive experimental work going on in this locality.

In short it seems to be the ideal method, suiting both the *jhumia* and the Forest Department, and orders have been issued that this method should be universally adopted henceforth.

A point worthy of mention is that, from observations, the extra growth from root and shoot cuttings will not interfere with the rice crop, as the growth of the plants is not sufficiently great to overtop the rice when it is ready for harvesting.

While cuttings put in at the middle of April have done extremely well in this particular plantation, the author feels that caution should be exercised in this respect. During 1935 a period of 32 days' drought occurred from the beginning of May, and seedlings died outright. In the author's opinion, therefore, to minimise this danger, cuttings should be put in during the first fortnight of May—still, it should be noted before the sowing of rice

Dhakpathar boom on the Jumna river.

A sleeper slide.

Photos : H. C. Khanna.

THE PABAR FORESTS OF LOWER BASHAHR DIVISION

BY H. C. KHANNA, D.F.O., LOWER BASHAHR DIVISION

A brief description of the Pabar valley forests of the Lower Bashahr Forest Division may be of some interest.

Situation.—These forests are situated in the catchment areas of three important tributaries of the Jumna river, *viz.*, Giri, Pabar and Rupin, within the limits of the Bashahr State. They cover an area of 997 sq. miles and lie between north latitude 31° 6′ and 31° 25′ and east longitudes 77° 25′ and 78° 26′. The quickest approach is from Simla, *via* the Hindustan-Tibet road (upper link); Baghi, the popular holiday resort, being at a distance of 50 miles. The road is excellent and passable for rickshaws. The shortest distance to Rohru, the headquarters of the Lower and Upper Pabar Ranges, is 62 miles *via* Kotkhai. Rohru is also reached from Chakrata in about 5 marches, and this route is not infrequently used by the travellers from Mussoorie to Simla.

Topography.—The tract is highly mountainous and typical of the Himalayas, the altitudes ranging from 4,500 to 16,000 feet. The forests are found up to 12,000 feet and above this stretch there are extensive areas of grass, rock and snow. The slopes are generally moderate except in the Rupin valley, where they are mostly steep and precipitous. The best known and most easily accessible peak is Hattu (10,500 feet) above Baghi. The view from there is magnificent and on a fine clear day Simla is visible.

Geology.—The principal underlying rocks consist of mica or quartz schists with some granite and gneiss in the upper parts. These rocks disintegrate into clayey and loamy soil admirably suited to *kail* (*Pinus excelsa*) and deodar (*Cedrus deodara*).

Climate.—The climate approaches that of Simla and, except the low valleys, which are hot and malarious in June and September owing to extensive paddy cultivation, is generally very healthy. The valley receives the full force of the monsoon and during the rains the whole tract is very wet. The autumn, with its clear blue skies

is delightful, while the winter, except at high elevations, is not severe. Snow seldom lies long below 6,000 feet. The average rainfall is about 60 inches.

Flora.—The forests stretching from 5,000 feet to the limit of tree growth present a great variety of vegetation. In the medium zone (5,000 to 8,500 feet) the principal species are *kail* and deodar. *Chil* occurs on the lower slopes in a limited area. The upper belt contains spruce, silver fir, and *kharshu* oak forest commonly found in the Himalayas. In the damper situations are found walnut, horse-chestnut, birdcherry, and maples. Ash occurs in a small area in the Rupin valley. Higher up these species gradually disappear and give place to silver fir birch, rhododendron and mountain ash.

History.—The history of the forests may be divided into 4 periods.

1864—1883.—The "inspection" period. In 1864 the forests were handed over by the Raja of Bashahr to the Punjab Government but in 1870 they were transferred to the United Provinces Government. During this period the forests were inspected by several forest officers, including Sir Dietrich Brandis and Sir William Schlich, with a view to get an idea of them and to know what treatment they required.

1884—1903.—The "protection" period. In 1888 the forests were once more placed under the control of the Punjab Forest Department and have remained so ever since. During this period 34,652 acres were demarcated and rights recorded. A start was made with improvement fellings in favour of deodar, and deodar sowings were done. While the deodar forests were worked in selection fellings the *kail* remained untouched, being then unmarketable. Protection steadily improved, and specially in regard to fire it was remarkably successful.

1904—1923.—In 1912 Mr. A. J. Gibson prepared a Preliminary Working Plan report and proposed to work the forests under the "Group System." In 1916, Sir George Hart visited the Pabar and issued a most valuable inspection note. The most important recommendations were the abandonment of periodic blocks in

compact "ring fences" and of the definite prescriptions of the "Group System." Between 1916 and 1921 the modified prescriptions of the Preliminary Report were carried out and fellings became more like the recognised Uniform method. In 1921 occurred disastrous fires which destroyed pole crops and regeneration over a large area. The total area burnt was 39,768 acres. During this period 471 acres of deodar plantations were created.

1924—1934.—The first working plan, prepared by Mr. Kitchingman came into force from 1924. The forests were divided into 2 circles, *viz.*, the Regular and the Protection, the former containing the majority of the forests. The forests in the Rupin valley were, however, worked on selection principles. Regeneration fellings were carried out in most of the P. B. I. areas and, on the whole, good results were obtained with regeneration. In particular, excellent progress was made in artificial restocking with deodar large fire blanks of 1921 and 1930 fires, an area of 1,440 acres being stocked during this period. Experience of the working of the plan, however revealed certain serious shortcomings and the plan was completely revised in 1934.

System of Management.—Under the revised working plan (Aggarwal), which has come into force this year, the forests have been divided into four working circles.

All the demarcated *kail* and deodar forests, situated on moderately easy ground and likely to respond to regular methods of management, have been included in the Shelterwood Working Circle. It is notable that, owing to the uneven nature of the crop and to avoid sacrifice of immature trees the text-book shelterwood system is modified to allow the retention of compact blocks of pole woods to form part of regeneration.

Mixed deodar, *kail* and fir demarcated forests topographically unsuited to concentrated regeneration fellings have been allotted to the Selection Working Circle. Even so, compact groups of even-aged trees, occurring on patches of easy ground, may be regenerated by shelterwood fellings. In this circle are also included the

undemarcated forests in which closure is impossible without the Raja's consent.

A Fir Working Circle has been formed to allow of meeting a possible demand for fir in the near future. Inaccessible and remote areas which cannot be worked for export are put in a separate Protection Working Circle.

For forests outside P. B. I. a thinning programme is laid down. In the Shelterwood and Selection Working Circles 712 acres have been prescribed for planting with deodar in the first 6 years. Deodar and *kail* yield has been fixed at 303,000 cubic feet in the round per annum and an annual surplus of Rs. 7,300 is anticipated after deducting Rs. 20,000 paid as share of the Lease money.

Produce extracted.—Timber in the form of scantlings, mainly from deodar and *kail*, is the only marketable product. B. G. sleepers and scantlings of large cross sections alone are saleable at any appreciable profit. The trees are sold standing and extracted by the purchasers. The Pabar river and its tributaries form the only line of export. The timber is floated down to the Dakhpattar boom, whence it is rafted down the Jumna river and the canal to Jagadhri on the North Western Railway.

People.—The country is comparatively densely populated. The population, which is on the increase, is entirely agriculturist and largely depends on the forests for its existence. With the increase in population the forests are diminishing due to heavy demand for new land for cultivation.

The people are mostly illiterate and backward. Generally the men are lethargic and indolent, the brunt of the work falling on the womenfolk. Sanitary conditions in the villages are appalling and diseases like small pox, etc., take a heavy toll of life. Polyandry is prevalent in the Rupin valley. The people are predominantly orthodox Hindus, only a few residents near Rohru being followers of Islam. They worship local deities or *deotas*, believe in gods and spirits and are very superstitious.

Shikar and Fishing.—The control of shooting is in the hands of the Raja. Except in remote areas the game is scarce due mostly

to poaching and to the large number of fire-arms. Nevertheless a great variety of game is met with. Big game includes goral, baral, barking deer, thar, serow and musk deer. Black bear and leopard are not uncommon while some red bear are found at high elevations. The common Himalayan game birds are well represented by the koklas, kalij, chir and monal pheasants, chikor and black partridge. Musk deer are heavily poached and only very strict restrictions on the issue of the shooting licenses can save this valuable animal from extinction. A game sanctuary exists near Baghi, but only in name. Attempts made to introduce trout in the Pabar have failed so far.

DOWN IN THE FOREST SOMETHING STIRRED

By Alyson Minchin, I.F.S.

Reading in your October number the story: "Jungle Wiles—the tale of a horn," another rhinoceros story came to mind. But is it too sensational for the Forester ?

It used to be told by a now—to our sorrow—retired Deputy Conservator, to his new I. F S. officers ; as part of their training, no doubt.

(Will he forgive a poor rendering, which lacks the supreme shock of his own delivery ? and....may we commend the incident to Walt Disney, inventor of Mickie Mouse ?)

His story goes thus:—

" I was looking at a new forest road in Bengal, when the front wheel of my Tin Lizie began to give trouble. I got pretty hot, working at it. After a bit I went and rested against a tree ; mopped my brow, and removed dirt out of the big crown-nut of the hub.

I was startled out of my meditations by the noise of something coming swiftly nearer, through the forest. It was a terrible uproar, earth-shaking ! like an express train rushing out of a tunnel. *A huge rhinoceros was charging me !* His head was down, and his horn, full two feet long, pointed straight for my middle ! *Petrified*

with terror I succeeded only at the last moment in springing out of his way....

The monster's impact drove his horn *through* the tree and out the other side !

Furious then were his efforts to free himself. Alas ! why hadn't I brought my gun ? what was I to do ? In a matter of seconds he would succeed in wrenching his horn free ! Helpless. I wrung my hands ! and in this paroxysm of horror became aware of...... what ?......the Ford crown-nut in my hand ! Round the tree in a flash I went ! and with the strength of frenzy screwed that ever-blessed nut on to the tip of the protruding horn.

Then only I drew my breath......the rhinoceros was securely held. At my leisure I fetched a rifle and shot him."

THE BAMONPOKRI TEAK PLANTATION

By Y. S. Ahmad, I.F.S., D. C. Forests, Bengal

The teak plantation at Bamonpokri is one of the earliest of its kind in Bengal and its history will be of interest to many foresters.

Situation of the Block.—The Bamonpokri block lies about 13 miles from Siliguri in an east-north-easterly direction and about a furlong to the north of the Siliguri-Pankhabari road, which is really a part of the Old-Military road from Siliguri to Darjeeling. It is situated at the lower extremity of one of the subsidiary spurs of the outer Himalayas running in a southerly direction.

Boundaries.—It is bounded on the north by a demarcated line which separates it from private forest land called Mount Periera, on the south by another demarcated line parallel to the Siliguri-Pankhabari road, on the east by the Rakti, and on the west by the Rungsung *kholas* (rivers) respectively. The narrow strip of land on the south was once cultivated with paddy but is now under tea.

Configuration.—The northern part of the block is narrow and it gradually broadens out towards the south. At the northern

extremity is a steep hill, about 2,000 ft. above sea-level, reaching down to the two rivers on the east and west. The southern slope is not so precipitous near the top, and is gradual further down till it reaches an elevated plateau, about 500 ft. below the top. This plateau is bordered by steep slopes on all other sides. The western slope descends to the Rungsung river, the south-western to the level of the Terai near the boundary, and the south-eastern and eastern slopes lead down to another plateau. The upper plateau contains a depression near its southern extremity, called *Pokri* or tank, from which the block gets its name ; the *Pokri*, however, during the winter belies its name. The lower plateau is about 1,000 ft. in elevation and slopes gently towards the south. It is bounded on the east by a precipice descending to the Rakti river, and on the south-west by a high bank ; towards the south-east, the prevailing slope of the pleateau continues a long way beyond the boundary terminating in the Terai proper.

Geology and Soil.—The hill at the northern part of the block is composed of Damuda sand stones and clay stones, dark in colour and much fractured and metamorphosed by the later uplift of the Himalayas. The soil here is a shallow sandy loam. The underlying rock in the upper plateau consists of tertiary sand stones of the Nahan series. The soil is a deep sandy clay, brown to grey in colour. The lower plateau is the old alluvium deposited in the form of a terrace. The soil is a micaceous sandy loam, deep and coarse and gravelly on the northern part.

Climate.—From the records of the neighbouring Tea Estates, it has been found that the temperature varies between 41 degrees F. in January and 93 degrees F. in April. The total average rainfall is about 190 inches.

Early History.—This land is a part of the tract taken by the British Government from the Raja of Sikkim after the military expedition of 1850. It was first leased out to a Mr. Barnes as waste land. The southern part of the block was *jhumed* (shifting cultivation) and cultivated with paddy. It was resumed by Government for default of rent, and made over to the Forest Department in 1867,

when an attempt was made to plant up the gaps caused by *jhuming* and filled with dense tall grass.

History of Teak Plantation.—At the time teak (*Tectona grandis*) was sought to be introduced in all localities suited to it and the first teak plantation in the Bamonpokri forest, with seeds from Burma, was started as an experiment in 1868 on cleared land, the valuable species like sal (*Shorea robusta*) and *satisal* (*Dalbergia latifolia*) were left on the ground.

The lower part of Bamonpokri block is divided into two parts by the Bamonjhora, the eastern part was called Rakti block and the western part, Garidhura block. Teak was planted chiefly in Rakti block. The first plantation was started in August 1868 near the southern boundary and continued year after year northwards up to 1877, except in 1874 when no planting was done. The 1873 plantation was practically a failure, and the 1872 plantation had also a few blanks which were all beaten up in 1874, so no new plantation was made that year. In 1877, Rakti block was completed and it was proposed to stop further plantation and watch what was planted out. Up to 1871, teak was grown pure, the seeds having been sown at stakes 6 feet apart. From 1871 teak seedlings were first raised in nurseries and then planted out in mixture with other species in specially prepared holes, 1 ft. × 1 ft. and 1 ft. deep, locally called *thalies*. Lines were first staked 10 feet apart and the *thalies* were prepared at distances of 5 feet from each other in the line. The teak seedlings were planted out in these *thalies* at distances of 10 feet and sometimes 15 feet from one another. In the intermediate *thalies* local species, chiefly *toon* (*Cedrela microcarpa*), were put out. Some exotics like mahogany (*Swietenia mahagoni*), ironwood (*Xylia dolabriformis*), *baobab* (*Adansonia digitata*) were also tried, but without success.

In 1874 Mr. Gamble drew up a planting scheme according to which *thalies* were made 5 feet apart and hoed; teak seedlings were planted in every third *thali* and *toon* in the rest. This was acted up to only for a year and then teak was put in half the number of *thalies* for two years. The whole area was fire-protected and, as a result, it was found that the dense crop of tall grass was replaced by a young

crop of sal throughout the block, and consequently regular plantation was abandoned from 1877; in 1879, the 1871 plantation in the north of Garidhura block was extended in order to complete its regeneration, and the low ground near the southern boundary was planted up in 1880 and 1882 with *jarul* (*Lagerstroemia flos—reginae*) mixed with teak and other indigenous species.

From 1880 to 1887 blanks were filled up or valuable species introduced to grow with the existing reproduction in the following ways :—

(1) In the forest containing many blank areas, planting was done in circular patches of 10 feet to 12 feet diameter, 25 feet apart, putting one teak plant of 1 to 8 feet, even 10 feet, high in the centre with a few seedlings of other species on the periphery and no tree was cut.

(2) In the forest worked over for timber or for firewood and charcoal, seeds of valuable species were sown broadcast in similar patches laid out 50 feet apart.

(3) Seedlings were planted 5 feet apart in 4 feet wide lines, cleared 20 feet apart.

(4) Seeds were sown broadcast all over the cleared and burnt coupe.

The seeds broadcast were those of sal, sissu (*Dalbergia sissoo*) and *lampatti* (*Duabanga sonneratioides*); the seedlings planted out were those of teak, *toon* and *satisal*. The last teak planted in Bamonpokri was in the compound of the Forester's quarters in 1888.

The growth of the plants was on the whole rapid; in the best parts the plants formed a closed canopy in less than 4 years and killed all grass underneath their cover. In 1881, the best grown teak in 1868 plantation, 12 years after formation, measured 2 feet 7 inches in girth. In 1930 the girth of the average tree was 4 feet 6 inches, not considering the suppressed trees which had not been cut out, and the utilisable bole was 40 feet long. In 1934 the girth of a similar tree was 5 feet and its utilisable bole 50 feet.

The first thinning in the teak plantation was started in 1882, 13 years after formation of the earliest plantation, and carried out gradually over all the plantations. Up to 1930, the operation was

repeated four times. In the early thinnings, other valuable species like sal were favoured and allowed to grow in mixture with teak.

The total expenditure up to the end of 1877-78 was Rs. 28,117-12-10 and up to 1917 Rs. 40,351 in all, the additional Rs. 12,233 were spent mostly on experiments and cultural operations. The total income up to 1917 was Rs. 1,074-1-8. The total area of teak plantation from 1868 to 1888 was 270 acres.

REVIEWS

EFFECT OF THINNING IN PLANTATIONS ON SOME OF THE PHYSICAL FACTORS OF THE SITE AND ON THE DEVELOPMENT OF YOUNG NORTHERN WHITE PINE AND SCOTS PINE

(*W. R. Adams Vermont Agric. Expt. Station Bull.* 390. *June* 1935. *Burlington, Vermont, U. S. A.*)

The author, Dr. W. R. Adams, is a member of the Botany Department staff in the University of Vermont, and has published some earlier thinning studies as previous numbers of this series of " Studies in Tolerance of New England Forest Trees." The object of the present study was to find what changes occurred in the physical factors of the site following a thinning. Much previous work has been attempted in the measurement of stands to show the effect of thinning upon the actual stand itself, but this is the first attempt which has come to my notice at measuring all the physical features,

such as wind movement, evaporation, precipitation, available moisture in the soil, etc., in so far as these are affected by the thinning operation. A great amount of painstaking work must have gone into this research, both in the collecting of a mass of statistics and in analysing these both mathematically and graphically to bring out conclusions, and many interesting points have come to light.

Two sets of comparative plots were established for thinnings in *Pinus strobus* and *silvestris*, and data for both ground and crown conditions were collected during three summers. The crown conditions of light, heat, humidity, wind movement, etc., were measured from a platform built on a wooden tower whose height was raised each year so that readings were for average crown height in each case. The ground conditions were measured 8 inches above the soil surface, as giving a more accurate picture of ground conditions than is given by the usual meteorological practice of taking readings at 4½ feet above ground.

The thinnings appear to have been fairly heavy. In the strobus the thinned plot, age 20 years and 25 feet high, had 106 living trees in a plot ·084 acres in size—*i.e.*, 1,262 stems per acre,—and this was reduced by 45 per cent. of the basal area, or 55 per cent. by stems, to 702 stems per acre. The unthinned check plot was only ·053 acres in extent, and carried 62 living trees to start with—*i.e.*, 1,170 stems per acre, a figure which was considerably reduced during the three years by natural deaths. Without knowing the site quality of the area and the height to which these crops would eventually grow, it is a little difficult to gauge the exact intensity of the thinning according to Indian standards. If this crop is to grow to a mature height of 120 feet, the intensity of thinning does not appear to be unduly heavy, as it would fall between D and E grades for deodar of site quality one, but if the growth is to stop at, say 75 to 80 feet, as is common in much of the New England pine belt, a reduction to 700 stems at this stage appears to be considerably heavier than has so far been contemplated in any Indian conifer work.

A further point that might strike the practical forester is that for testing the general effect of a thinning upon, let us say, the available

soil moisture, a thinned plot of ·08 acres, say 20 × 20 yards, is very small indeed. The report dces not say whether the surrounding was thinned to the same intensity, but if it was not, and it does not appear to have been, then the effect of wind and the consequent evaporation would surely be masked and reduced for the plot itself, compared with a larger area of woodland in which the thinned condition was general.

The data collected do show very clearly that of the various physical factors, several were obviously affected by the thinning of the canopy. Wind movement increased both in the crowns and at ground level, likewise the evaporation at both points, and the solar energy, as one would naturally expect from such an opening. The amount of precipitation reaching the soil also increased with the thinning, but the accuracy of the figures was interfered with by the additional drip from the branches of the unthinned plot. In working out the effect of any canopy on rainfall, a very large number of rain-gauges is needed to average out such errors.

A decrease in the percentage of *available* moisture content was registered in the soil of the thinned plot when the *total* moisture content was high, and an increase was registered when the total was low. This is an important point to have substantiated, because it indicates a rather unexpected reason why thinnings are so inevitably followed by an increase in increment; with an extra supply of *available* moisture in times of drought, the tree in a thinned forest can continue growing further into the summer after the unthinned plot has exhausted its spring wood-building activity.

The changes in air temperature and in relative humidity were negligible.

An interesting point is the great variation in the tendencies of these records for different years. In some cases, such as the wind movement data, the record for any one year gives an entirely different conception of the relative conditions in the thinned and unthinned canopy, and the average for the three years is not actually like any of the single years. This emphasises the need for carrying out any such measurements over a series of years in order to strike a reliable average.

To test the comparative quality of the wood in these plots, the specific gravity of the timber actually produced in the four years following the thinning was measured. In the strobus no significant difference was found, but in the Scots pine the best stems in the thinned plot showed a 3 per cent. increase in specific gravity compared with those of the unthinned plot.

A very comprehensive review of thinning literature, mostly American is given, and the methods of collecting the data and of working out the statistics should be of considerable interest to all foresters employed on silvicultural research.

R. M. G.

ANNUAL REPORT ON FOREST ADMINISTRATION IN STRAITS SETTLEMENTS FOR THE YEAR 1934

Forestry in the Straits Settlement is yet in an undeveloped stage. The forest administration is confined to an area of 181 square miles of reserved forest representing 12·7 per cent. of the total area of the Colony. Services of the staff are mostly shared between here and the Federated Malay States; as their management and other problems are common in many respects. In view of the silvicultural importance the Malayan Forestry has assumed of late, particularly with respect to the problem of the regeneration of the Tropical Evergreen Forests, this report has obviously a peculiar interest to the Indian Foresters faced with the same problem in its varied aspects. A method of "Regeneration Improvement Fellings"—which include girdlings also—were carried out departmentally in most of the areas, where contractors could not possibly be induced to remove inferior species owing to the absence of a market for firewood. In comparatively richly stocked areas, however "preliminary timber fellings" were done in which a proportion of the mature stand was removed before the departmental treatment to induce regneration was applied. Another operation, known as "Seedling fellings," has been in progress—carried out by licensees—where the inferior species are removed in the form of poles and fire-

wood, to favour regeneration of the more vauable timber trees. It is interesting to note that these "fellings" are somewhat on the lines of experiments carried out in South Bengal and the Andamans during the last quinquennium. The total outturn from sawn timber, logs and poles from forest reserves is going up appreciably, whereas that from crown lands is going down, indicating the progressive depletion of forests of the latter category. The "forest organisation" in Singapore was an important event of the year, having, as its main objective, the marketing and development of the local sawmill industry and the extension of the trade in Malayan timbers at home and abroad. The standard of grading has already gained recognition in the United Kingdom and exports are steadily increasing. Financial results indicate that the actual revenue in 1934 rose beyond expectation, from $23,050 in 1932 and $21,250 in 1933 to $32,083 whereas, the expenditure remained practically at the same level $68,103, $65,883 and $68,676 during 1932, 1933 and 1934 respectively. The revised financial arrangements between the two governments and the progressive rise in revenue might reduce the deficit in the near future.

J. N. S. G.

EXTRACTS

LES SOURCES SECONDAIRES DE L HUMIDITE DE LA TERRE ARABLE

PAR L. CHAPTAL

SUMMARY

Rainfall is generally considered to be the principal source of soil moisture. The proportion available for the use of plants is affected by the intensity of the rainfall, the rate of absorption by the soil, and by the rate of evaporation.

It has long been recognised that moisture may rise to the surface from lower layers by capillarity and by distillation; but it is only in exceptional cases that these sources can be of importance.

Mist and fog in cold countries and dew in hot countries can furnish moisture to soils, but it is shown that these sources cannot be very appreciable.

A more important secondary source of moisture, at least in Mediterranean regions, is absorption, which takes place, even from atmospheres which are below saturation. Hygroscopic moisture may pass over into capillary moisture with rising temperature and thus become available for plants.

D

In an experiment, 10 cb. metres of limestone pebbles were enclosed in concrete with holes to permit access of air and with an arrangement to collect water draining down. During the hot season, 88 litres of water, with a maximum of 2·5 litres per day were collected. This phenomenon is distinct from condensation, since it occurs when the absorbing material is warmer than the surrounding air, and is due to the transference of hygroscopic moisture into capillary and ultimately into gravitational water.

The importance of this source of moisture in hot climates is emphasised.—*Imperial Bureau of Soil Science, Pamphlet No.* 2434, *p.* 39).

CURIOUS THINGS DONE BY INSTINCT

Instinct is the dominating force that controls nearly all animal life. It is born with the animal and takes possession of the animal's activities at once. It is thus that our animal friends perform such complicated acts—themselves in total ignorance of how they are done. These instincts are inherited and are independent of experience.

The most complicated instinctive behaviour occurs in the insects. But all other animals exhibit interesting instincts too. Some of these instincts seem very strange to us, and often do not appear to have any relation to the animal's welfare. However, in their usual setting, there is probably a purpose in every instinct. We shall consider some of the most interesting ones.

First we note the perfection and wisdom of instinct. Why do butterflies seek for a certain kind of plant on which to lay their eggs? Are they aware that the caterpillars which hatch from these eggs must have their particular plant for food? Or are they led blindly to that plant, unaware of why they go? They never live to see their own eggs hatch and they have no way of knowing what food is used, so we must conclude that they are led by blind instinct to these plants.

Many wasps kill their prey, such as crickets or caterpillars, and then they bury them in the ground along with some eggs. When the eggsh atch, the buried caterpillars serve as food for the young. Does the mother wasp know this when she buries them? Certainly not. She does not know why she does it.

The precision of instinct is also shown in these same wasps. They always sting their prey exactly in the vital nerve spot. Where did they learn that? They did not learn it. They did it perfectly the first time they seized a victim.

Why do honey bees make hexagonal cells? Do they choose this shape? Do they know that it is the most economical shape for such structures? Have they ever considered a change? Probably not. This is another example of the perfection of instinct.

When pups are born, how does the mother dog know that she must bite off the umbilical cord (navel)? She does not know. It is a wise instinct of which she herself is not aware. Why does she take the puppy's nose in her mouth and start the first breathing? For the same reasons.

Some Brazilian ants (atta sexdens), described by Dr. Jacob Huber, have a curious habit of carrying bits of leaves into their underground nests where small gardens of white fungus are grown on the leaves. These ants care for the gardens carefully and manure them from their own body secretions. The fungus serves for their food. When the queen leaves to start a new colony, she carries a little of this fungus under her tongue, so that after the wedding ceremony she can start a garden in her new nest. Such apparently intelligent procedure makes us wonder if they do not really understand what they are doing. However a study of their activities convinces one that none of this was learned or thought out, but resulted only from instinctive motivation.

Birds, fishes, and all other animals obey similar urges from within and do not know why. Man himself performs many of his activities from the same inner promptings.

Many instincts appear to have a definite rhythm, and one act must follow another act without exception. For example, I have often watched mason wasps follow their fixed cycle of instinctive behaviour on a summer day. First, the female builds a cell; second, she lays an egg in it; third, she stuffs the cell full of paralyzed caterpillars; and fourth, she seals over the cell. If the eggs are destroyed or removed from the cells as fast as they are laid, it makes no difference to Mrs. Wasp. She must go on with the cycle. So she stuffs the cells full of caterpillars and seals them over even though the eggs are gone.

In a similar manner, hunting wasps paralyze caterpillars, deposit eggs in them, bury them, and then cover over the hole. If the caterpillars are taken out of the hole, the wasps will seal it up with as much care as they would if the caterpillars had not been removed. They are impelled to go on with the cycle of activity.

Spiders have a definite cycle of instinctive behaviour in building their webs. If a portion of the web is completed and the spider has gone on to another phase of the web-spinning, she will not return and rebuild the first part if it is destroyed; the cycle of instinct does not permit any back-tracking.

All of these examples show the perfection and exactness of instincts, and they are directed to certain ends. They also show that instincts move in definite steps of progression, each step suggesting the next. Animals perform instinctive acts with ease and precision at the first attempt, following a clear but unintelligent course of action. It is a sure path, but a blind one.—(*Forest and Outdoors, July* 1935).

LIGHT AND FUNDAMENTAL LIFE PROCESSES OF PLANTS

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Introduction

The phenomena of light are mainly studied by physicists, but the knowledge derived from their labours about the nature of light is of great importance to those who study the life processes of plants. If we go to the very root of things it becomes

abundantly clear that there can be no life without light and the sensation that we know as light can only be experienced through the medium of life. Light is known to be the carrier and supplier of energy without which life cannot exist. It is therefore natural that the recent advances in the study of the physical nature of light have been of great interest to plant physiologists and are paving the way to the right understanding of the various processes taking place in plants under the influence of this all important phenomenon of Nature.

Plants by virtue of their unique activities entrap the energy that they receive from the sun's rays, work it up in a mysterious manner and produce the complex organic substances which not only maintain them in the state of living, but also maintain the multifarious forms of the animal life in the living state on the earth. The energy of the sun's rays that is harnessed and stored up in these products of plant manufacture is liberated again in an equally mysterious manner and becomes available for the important manifestations of the living organisms. Thus the living is made possible by the energy that is primarily derived from sunlight through the agency of plants whose strength, to use the quaint saying, was supposed to lie in standing still.

The sensation of light firstly makes us conscious of the entire Universe and all that it consists of. It has made possible the stock of human knowledge and experience that we now so proudly possess and that we so rapidly enlarge. Secondly the energy of light is the mainstay of living organisms. We are here more concerned with the second than with the first proposition. The first is the outcome of the second. It is therefore of paramount importance to direct our efforts to the study of these beneficent processes in plants that make the living possible. The knowledge of these processes will benefit mankind more than any other discovery in science and any small attempt to add a few facts to the existing stock of knowledge about these processes will be an attempt in the service of mankind. It would be, therefore ,in my opinion, a fitting occasion to speak on the present state of knowledge of the relations of light to these processes by which complex-organic food substances are manufactured before this society which has, as its aim, the promotion of research in different fields of the plant sciences.

Light and Synthesis of Carbohydrates

The importance of light on synthesis of carbohydrates in leaves was first noticed by Ingen-Housz (1779). Senebier (1788) next observed the effect of light of different colours in the formation of starch in leaves. This work was extended by Gilby (1821), Daubeny (1836) and Dumas and Boussingault (1841). Draper (1844) next pointed out that the yellow region of the visible spectrum was the most effective, but later Lommel (1871) showed that the photosynthetic activity was highest in the red yellow region. Timmiriazeff (1869-89) confirmed the findings of Lommel and he (1890) showed that the formation of starch increased from the red end of the spectrum towards the violet end. Englemann (1882-1884) on the other hand found by his bacteria method a secondary maximum in the rate of the process in the blue violet region. In all these experiments no attempt was made to keep the energy contents

of the different rays of light the same. This defect was removed by Kniep and Minder (1909) in their experiments. These authors concluded that the rate of photosynthesis was the same in the red (620 *uu* to infra red) and the blue (523-340 *uu*) regions and the process was at a standstill in the green region (524-512 *uu*). Though they made the intensities of the different rays equal in these experiments they used very low light intensity which acted as a limiting factor. They also employed an inaccurate method for the measurement of photosynthesis.

Ursprung (1912) further showed that the process of photosynthesis occurred only in the visible region of the spectrum of white light, the maximum being in the red region. The work of Ursprung (1917-18) fixed with certain degre of accuracy the exact spectral limits of photosynthesis, though they varied in the case of different plants. The photosynthetic activity was also found by Lubimenko (1923) to be more intense in the red region (760-600 *uu*) than in the blue region (480-400 *uu*) of white light. The discovery of this fact has stimulated research on the effect of different wavelengths of light on photosynthesis. The difficulties of experimentation on this problem are so great and in some ways so insurmountable that experimental work done by different workers on this aspect of the problem is defective for one reason or another. In order to obtain reliable experimental data it is necessary to make the total intensity of incident rays equal in all cases. Even when that is done, it is not certain if the different rays like the red and the blue are absorbed by a leaf to the same extent. If that is not the case the rates of photosynthesis in the two parts of the visible spectrum cannot be compared.

Light of different Wavelengths and Photosynthesis

Attempt was made by Wurmser (1920-21) to determine the general relations between the quantity of energy absorbed from lights of different wavelengths and the rate of photosynthesis and came to the conclusion that green light was utilised in the photosynthetic work to about four times the extent of the red. To express it in physical terms the utilisation factor, *i.e.*, the ratio of the quantity of the light energy absorbed to the amount which is transformed into chemical energy, increases from red to green from 60 per cent. to 70 per cent. The main objection to the results of Wurmser (1920-21) is that the method of calculating the amount of absorbed energy has no direct physical basis. This difficulty is met by Warburg and Negelein (1923) by using a silvered vessel for the assimilating material so that the incident light energy is taken as the energy absorbed. They found that the efficiency of the photosynthetic system decreases with decreasing wavelength. Thus the utilisation factor shows decrease from 60 per cent. to 40 per cent. which is in accordance with Einstein's Law of Photochemical Equivalence. In these experiments by Warburg and Negelein the errors in determination of the energy absorbed by the assimilating organism are not removed. It is necessary to determine the fraction of light energy that is absorbed by the green pigments alone. Some energy is also absorbed by the colourless components of the tissues. Briggs (1929) tries to avoid the sources of error in measuring the absorbed amount of energy by an indirect method from the volume of oxygen evolved in photosynthesis, the energy utilised in

the process is calculated from the heat of combustion of glucose to produce one cc. of carbon dioxide which is taken as equal to oxygen evolved. His results also confirm the findings of Warburg and Negelein (1923). In his experiments the energy incident on the leaves is not the same in the three regions, yellow, red, green and blue. The rates of photosynthesis are afterwards calculated for the same incident energy, *i.e.*, per 500 calories per 100 sq. cms. of the leaf area per hour. This is objecticnable in the sense that the rate of photosynthesis in the different rays of light may not increase in the same proportion by the increase in their intensities. The incident light intensity employed by him is also very low.

The experiments done on the rate of reproduction in algae by Klugh (1925) also show that the rate of reproduction, *i.e.*, indirectly the rate of photosynthesis is highest in the red rays. Similar conclusions have been reached by Moore, Whiteley and Webster (1923) on the photosynthetic activity of the sea-weeds.

The main conclusion that can be drawn from the work quoted above is that the efficiency of the photosynthetic mechanism decreases with the decreasing wavelengths of light. All these costly and elaborate experiments do little more than confirm the findings of Senebier in 1788 with his simple technique of double-walled bell-jars containing coloured solutions.

The above conclusion does not however find support in the conclusions reached by Popp (1926) on the effect of the omission of the blue-violet and the violet regions of light on the growth of plants. The omission of these rays results in the greatly decreased production of carbohydrates in leaves. The results suggest that the blue-violet rays are important in the process in some way or the other.

Sunlight, Electric Light and Photosynthesis

Some fresh light on the question of the effect of different rays of white light on the photosynthetic activity is thrown by the experiments done in my laboratory on formation of carbohydrates in leaves exposed to sunlight and light from an electric lamp (Dastur and Samant, 1933).

The results clearly show that the photosynthetic process in green leaves does not proceed with the same speed in artificial light like a gas-filled electric lamp as it proceeds in diffused sunlight of the same total intensity. The formation of carbohydrates takes place very slowly and in small quantities in leaves of plants exposed to artificial light as compared with the formation of carbohydrates in sunlight. The spectrum analysis of the lights from the two sources showed that, though the spectral composition was the same, the distribution of energy in the different parts of the visible spectra was not the same. The artificial light was more intense in the yellow-red region of the spectrum than the diffused sunlight; while the latter was more intense in the blue-violet region than the former. The distribution of energy is fairly uniform in the different parts of the visible spectrum of sunlight while it is not so in the visible spectrum of light from the electric lamp. These observations open up the question of the effect of different wavelengths of light on photosynthesis. The artificial light is more intense in the yellow-red region of the visible spectrum (at a distance of 50 cms. at which the plants are exposed) than the diffused sunlight. If the efficiency of the photosynthetic system decreases with decreasing wavelengths

of light, the results obtained by us do not support this conclusion, as the artificial light is richer in those rays which are supposed to be photosynthetically efficient. These results suggest that either the blue-violet region of the visible spectrum is equally or more efficient in the process than the yellow-red region or that the whole region of the visible spectrum is photosynthetically effective, and the lesser proportion of any one region results in a depressed rate of photosynthesis. The total energy supplied by the different radiations of the visible spectrum is not the determining factor in the process, but the different radiations as such or the frequency of radiations are important for the process. If it is merely a question of energy derived from light radiations, the process of photosynthesis should go on normally in artificial light supplying the same amount of energy in terms of ergs or calories, as supplied by the sunlight. These findings make us look at the problems of the energetics and mechanism of photosynthesis from a new angle and it was considered to be of interest to extend these observations.

Photosynthesis in Lights from Different Sources

In order to obtain further evidence to support the above conclusions it was undertaken to determine the rate of photosynthesis in leaves exposed to lights from different sources. Four different artificial sources, an electric lamp, daylight lamp, an incandescent oil lamp and a carbon arc lamp were used. The measurements of the distribution of energy in the visible spectrum of each light were made in three different ways namely, (1) by micro-thermopile, (2) by photographic plates and (3) by taking spectrum photographs by means of Adam Hilger's constant deviation spectrameter. According to the intensities of the blue-violet regions the sources of light are found to be in the following order :—(1) Sunlight, (2) Carbon arc lamp, (3) Daylight lamp, (4) Electric lamp and (5) Incandescent oil lamp. The quantities of carbohydrates formed in leaves exposed to these five sources of illumination are also found to be in the same order. The quantities of carbohydrates formed in sunlight are higher than that formed in the carbon arc lamp. Similarly the carbohydrate contents of the leaves exposed to the arc lamp are higher than those of the leaves exposed to the daylight lamp. The carbohydrates formed in leaves exposed to the daylight lamp are significantly higher than the carbohydrates formed under the electric lamp and so on. As the total intensities are kept the same and as the main differences in the energy distribution in the different parts of the spectrum are mainly in the blue-violet region the only conclusion that can be drawn is that the blue-violet region must be playing an important part in the photosynthetic process and for normal photosynthetic activity both the red and blue-violet regions are equally important. If any one of the two regions is either absent or is of a very low intensity the normal photosynthetic activity does not proceed. (*Dastur and Mehta, in course of publication in the Annals of Botany.*)

Photosynthesis in the Red and Blue-Violet Lights

In order to put to test these conclusions, it was undertaken to measure the rate of photosynthesis in leaves exposed to monochromatic red and blue lights and to white light of equal intensities in the three cases. It was not found possible to use an

artificial source of light for obtaining large beams of monochromatic red and blue-violet lights of sufficiently large intensity in order that light intensity may not act as a limiting factor. So the experiments had to be conducted in open sunlight. Fortunately this was possible during the dry months of the year. For obtaining monochromatic lights solution filters had to be used. After several failures a solution of carmine in lithium carbonate one centimeter thick was used for the red light and ammoniacal solution of copper sulphate 1 cm. thick was used for the blue-violet light. The range of transmission of the red filter was 7,000 to 6,200 A° and that of the violet filter was 4,720 to 4,000 A°. The spectrum photographs of the filters showed no transmission in any other part of the spectra. The percentage transmission of the different wavelengths in the transmitted red and blue-violet regions were determined. The maximum transmission in the red region was 46·77 per cent. at 6,800 A° and in the blue-violet filters was 23·9 percent. at 4,200 A°. By determining the total percentage transmission of the two filters it was possible to make the total intensities of the two rays equal. As the microthermopile is not equally sensitive to the red and blue rays, an indirect and complicated method was employed to make the intensities equal. The intensities of the red light and white sunlight were reduced and made equal to that of the blue-violet light by interposing glass plates.

The glass plates used do not interfere with the transmitted red region or the white light except lowering the total intensities. This is verified spectrometrically. The results obtained with the three lights show that the formation of carbohydrates is highest in leaves exposed to sunlight, medium in red light of equal intensity and least in blue-violet light of the same intensity. The differences in the quantities of total carbohydrates formed in the red, blue and white lights of equal intensities are statistically significant. (*Dastur and Mehta, in course of publication in the Annals of Botany.*)

If the results obtained with red and blue-violet lights are alone compared, they will appear in agreement with those obtained by previous workers. But if the results obtained with the white light are taken into consideration, they support the conclusion that the efficiency of the photosynthetic mechanism is highest in the full visible spectrum of light than in the monochromatic red and blue-violet lights. The importance of blue-violet region in the process is again proved by these experiments.

In view of the results obtained the question of the energetics of photosynthesis acquires fresh aspects. It appears the energy carried by the different radiations is not the only determining factor in the rate of the process. If that was the case there should not have been marked and significant differences in the carbohydrate contents of the leaves exposed to sunlight, arc lamp, daylight lamp, electric lamp and also the sunlight and the red and blue-violet lights, all of equal intensities. Therefore the differences found could only be attributed to the differences in the distribution of spectral energy. The blue-violet rays are as important in the process as the red rays and so the frequency of the different rays is another determining factor. It is probable that for the different stages in the process all rays of different wavelengths are used as it is likely that for the activation of the different reacting molecules the rays of different frequencies may be essential.

In the case of *Helianthus annuus*, L., calculations show that the volumes of carbon dioxide that must have been decomposed in the white, red and blue-violet lights are 89, 22 and 7 cc. respectively. In case of *Raphanus sativus*, L., the volumes are 60, 32 and 9 cc. It is apparent that with the same amount of radiant energy supplied the efficiency of the photosynthetic mechanism in the red light is nearly three times that of the blue-violet light, while in the white light it is nearly four times its efficiency in the red light in *Helianthus annuus*, L. and is nearly double in *Raphanus sativus*, L. Thus the number of light quanta necessary for transforming a molecule of carbon dioxide increases in the white, red and blue lights as the utilisation factor decreases in the same order. Warburg and Negelein (1923) have estimated that the number of quanta absorbed per molecule of carbon dioxide reduced, should be four or five and they should remain constant at four for all wavelengths in the visible spectrum. The results here show that that is not the case unless if it be assumed that the energy absorbed by the leaves is highest in the white light, medium in the red light and the least in the blue lights. But this assumption is not borne out by the results obtained with the different sources of light enumerated above.

Protein Synthesis in Lights from Different Sources

An interesting point arises from the results of carbohydrates formed in electric light and in sunlight. It is very likely that the lesser amounts of carbohydrates formed in leaves exposed to the electric lamp may be due to their rapid utilisation in protein synthesis, while in leaves illuminated by sunlight the formation of proteins may be taking place slowly leading to the accumulation of carbohydrates. If this supposition is found to be true it would again raise fresh issues on the effects of lights on protein synthesis. So far light is known to play an indirect rôle in the synthesis of proteins inasmuch as it is instrumental in the synthesis of the carbohydrates which are needed for the construction of proteins. Zaleski (1897-1901), Zaleski and Tutorski (1912), Stoklasa (1916), Muencher (1923), Pearsall and Loose (1933) have shown that the synthesis of proteins occurs four times as rapidly in sunlight as it occurs in absence of light. If that is the case, the lights of different spectral intensities may also bring about the differences in the rates of the synthesis of proteins. It was therefore necessary to determine the protein content of leaves of the same species exposed to sunlight, arc light, daylight lamp and electric lamp as were done in the case of carbohydrates. If the rate of photosynthesis is really depressed as the source of light is progressively poorer in the blue-violet rays, results of the total protein content of the leaves should also decrease in the same order.

The technique of experimentation employed is the same as before. The methods of extraction and determinations of protein nitrogen in different forms are carefully worked out and used. The leaves and petioles of plants exposed to these different lights of equal intensities are analysed for water-soluble protein nitrogen, polypeptide nitrogen, diamino nitrogen, monoamino nitrogen, amido nitrogen, acetone-soluble protein nitrogen, alcohol-soluble protein nitrogen, insoluble residual nitrogen and total nitrogen. The plants used were the same as before, *viz.*, *Ricinus communis*, L., *Helianthus annuus*, L., and *Abutilon asiaticum*, G. Don. Results obtained are parti-

cularly striking and interesting in many ways. In the leaves water-soluble protein and polypeptides and diamino acids are definitely produced during the exposure, while monoamino acids and amides do not show any increase after exposure. It may be that amides and monoamino acids are rapidly converted into soluble proteins and polypeptides just as hexoses are supposed to be rapidly converted into starch. The results of the total protein contents of the leaves are in the order daylight bulb, arc light, electric light and sunlight, while the carbohydrate contents of the exposed leaves stand in the order sunlight, arc light, daylight bulb and electric lamp. If the carbohydrates supplied the basic materials for the formations of the proteins, the leaves exposed to sunlight should contain the largest quantity of proteins than those exposed to any of the three sources of light. If the supply of carbohydrates is not acting as a limiting factor the protein contents of the leaves should be equal in all the four lights. Why should there be an increased production of protein in the daylight bulb and arc lamp as compared to sunlight when the formation of carbohydrate is most rapid in the latter? It is evident that very small part of carbohydrates formed in the leaves by photosynthesis is utilised for protein synthesis as the protein content of the leaves exposed to electric light is slightly more than that of the leaves in sunlight, though the carbohydrates formed in the former is less than one half the amount formed in the latter. (*Dastur and Kanitkar, in course of publication*).

Conclusions

It is difficult to explain the differences in the synthesis of proteins in leaves exposed to different lights and still much more difficult it is to understand the low protein nitrogen contents of the leaves in sunlight where the photosynthetic activity is the highest. It may be possible that the machinery of the cells is clogged up owing to the very rapid production and consequent accumulation of the products of photosynthesis and hence the rate of synthesis of protein is depressed. In the case of electric light the protein synthesis goes on normally but its rate is inhibited by the depressed rate of photosynthesis, while in the daylight bulb and under arc lamp there is an increased production of proteins due to the increased rates of photosynthesis which however are not rapid enough to clog up the active cells. It is, however, difficult to understand why the protein synthetic activity should be inhibited in sunlight and the photosynthetic activity should continue unabated even after the cells are full of starch. It is also premature to say that the synthesis of protein is influenced by the differences in the spectral intensities like the synthesis of carbohydrates shown above.

It thus appears that the rays of different wavelengths of the visible part of the spectrum of white light are as important for the two fundamental constructive processes in plants as their energy contents. These results have added to our difficulties in understanding the energetics of the mechanism by showing that the respective intensities of the different radiations of white light are as important as their total energy contents. If the above findings are true, the synthetic processes of the plants are greatly influenced by variations in light intensities that normlly occur during the day and season of the year. The growth of plants is the net result of the constructive and destructive processes and if the constructive processes are so

affected by the diurnal or seasonal changes in the quality and the quantity of light, it is no wonder that the reproductive activities of the crop plants show such wide variations.—(*Journal of the Indian Botanical Society*, Vol. XIV, No. 1, March 1935).

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SUMMARY OF PROPOSALS FOR THE REVISED WORKING OF THE FORESTS OF HYDERABAD AND KARACHI DIVISIONS

CHAPTER I

BASIS OF PROPOSALS

Working circles.—The forests being uniform in character have been grouped in one working circle.

Sub-division into compartments.—The existing compartments to be maintained. These compartments are formed by 16′ wide cross parallel lines or rides cut half a mile apart, and are about 160 acres each in extent.

Analysis of the crop.—No volume valuation has been attempted in view of the method of treatment proposed. The stock has, however, been thoroughly examined by compartments, coupes or other convenient sub-divisions, and has been plotted according to species, age-classes and density. The stand thus plotted has been classified into three main classes, *viz* : —

(*i*) babul and *kandi* (*Prosopis spicigera*) areas.
(areas containing mixture of babul or *kandi* and *bahan* (*Populus euphratica*) or *lye* (*tamarix dioica*) have been included in this class);

(*ii*) *bahan* and *lye* areas ;

(*iii*) blanks.

Babul and *kandi* have been separated from *bahan* and *lye* because the former are readily saleable, while the demand for the latter is negligible. Babul and *kandi* areas have been further sub-divided into four classes based on the stage of growth. There are thus 6 classes as shown below :—

Babul and *kandi* :—

Overmature and mature (over 25 years in age) ..	.. Class I.
Advanced pole (over 18 to 25 years in age) ..	.. Class II.
Young pole (over 9 to 18 years in age) ..	.. Class III.
Areas under regeneration including those bearing sapling and established seedling growth (9 years and under in age)	.. Class IV.
Bahan and *lye*	.. Class V.
Blanks	.. Class VI.

The classification into crops has been done on broad basis. Thus a wooded area containing small blanks dotted about has all been shown as wooded and *vice versa*.

The various species occur in the following proportion :—

	Hyderabad Division.	Karachi Division.
Babul and *kandi*	73·9 p. c.	52 7 p. c.
Bahan and *lye*	15·4 p. c.	17·5 p. c.
Blanks	10·7 p. c.	29·8 p. c.

The area under babul and *kandi* is distributed amongst the 4 age classes as follows :—

Age class	Hyderabad Division.	Karachi Division.
I	24·5 p. c.	28·0 p. c.
II	8·2 p. c.	17·3 p. c.
III	22·2 p. c.	16·5 p. c.
IV	45.1 p. c.	38·2 p. c.

Both the Divisions contain excess of the highest and the lowest age classes with deficit in the two intermediate classes.

CHAPTER II

METHOD OF TREATMENT

Object sought to be attained.—The species occurring in these forests yield mainly fuel, which is in great demand. Babul timber is also in demand to a limited extent. The object of management, therefore, is to produce a sustained annual yield of fuel and to make provision for the production of babul timber, with due regard to the requirements of the local population specially in the matter of grazing.

Method of treatment.—The sanctioned method, *viz.*, clear felling on equal areas with reservation of babul trees for timber and regeneration by natural and artificial means to be continued.

Exploitable age.—The present exploitable age of 30 years to be continued.

CHAPTER III

GENERAL WORKING SCHEME

Felling series.—Under the plan under revision, the forests of the Hyderabad Division were divided into 59 felling series and of the Karachi Division into 57. They have now been divided into 30 and 28, respectively. The felling series have been made as large as possible consistently with the scattered situation of the forests and the availability of labour.

Conversion period.—The felling of coupes in adjacent areas cannot, however, be resorted to directly, without causing undue waste. At present growth in adjacent areas differs very widely in age; crops of all age classes are inter-mingled. Successive fellings on adjacent areas would therefore result, on the one hand, in much young growth being felled, and on the other in overmature and mature growth being left untouched to deteriorate. Some sacrifice is of course inevitable in any change over from one system of working to another; but every attempt should be made to reduce it to the minimum possible. With this view it is proposed that, during the next 15 years, to be called the conversion period, fellings and regeneration should be carried out according to the prescriptions detailed below, so that, at the end of this period a scheme of successive fellings can be put into effect. The period of 15 years has been adopted for conversion because:—

(1) it is desirable to fix a short period with due regard for the sacrifice involved; the period of 15 years is reasonably short;

(2) after its expiry, the youngest crop in the first year's area of exploitation will be 15 years old and will have attained at least the exploitable girth of 27″ to 30″. A shorter rotation must involve the cutting of growth of uneconomical size during the first few years of the succeeding normal rotation.

Calculation of the yield—(*a*) *The crops available for felling* should be the following, in the order given;

(1) Class .

(2) Class II except in felling series where regeneration is backward.

(3) One-third of class III in felling series where regeneration is established and adequate stocks of this class exists.

The age classes are at present so unevenly distributed, and the progress of regeneration varies so much between the several felling series, that it has been considered necessary to deal with each felling series on its merits. The above is given, as a broad indication of what crops may be regarded as available for felling.

The area of the annual cut has been calculated as follows:—

(*i*) 1/15th of the area available for exploitation as in 1 above

or

(*ii*) 1/30th of the area under babul and *kandi* whichever is less.

Scheme of fellings.—As the forests are subject to continual changes due to the action of the river—changes which affect the areas of the felling series under the various kinds of crops from time to time, any programme of felling now prepared for the entire conversion period will need periodical modification to suit the changed conditions. For the present, therefore, it will be enough to state the main principles on which fellings should be based during the conversion period and to work out a programme for the first few years. A programme for the first four years has been worked out. The main points to be observed should be:—

(*i*) The succeeding annual coupes should be adjacent to each other, and the fellings in these coupes should be restricted to the crops available for exploitation, as in (*a*) above;

(*ii*) Successive fellings should follow the direction east to west, or north-east to south-west, to guard against damage from windfalls in the inundation season, when the prevailing direction of winds is west and south-west;

(*iii*) The fellings may advance on a two compartment front if this results in more concentrated working than on a one compartment front;

(*iv*) An equal area annual felling need not be *rigidly* maintained where it results in detached areas having to be worked, provided that total correct area due is felled during each period of 4 years;

(*v*) Where the present class III crops have to be felled, such fellings should be as late in the conversion period as possible;

(*vi*) The clear felling of *bahan* and *lye* areas included in the year's coupe may be undertaken in localities where there is demand for such species, and must be undertaken where the ground under them is fairly high to enable babul to be successfully regenerated. In such areas all except overmature babul and *kandi* of and under 15″ in girth should be reserved against fellings;

(*vii*) Overmature babul and *kandi* occurring in the areas considered as blanks or in *bahan* and *lye* areas other than those referred to in (*vi*) above, included in the year's coupe can be felled in addition to the prescribed cut.

Reservation for babul timber.—Standards in singles have so far been a failure. Reserved in groups, they have given more satisfactory results. Accordingly in mature and advanced pole babul crops, trees should be reserved in groups, total area of the groups so reserved being limited to 10 per cent. of the year's felling area in

that felling series. Standards need not be reserved in areas where facilities for transport of large sized logs are lacking or where extraction cannot be carried out at remunerative rates.

The nature and mode of fellings.—Fellings are to be carried out as hitherto. At the commencement of the main felling work 25′ wide strips on each side of alternate compartment lines included in the year's coupe (*vide* under fire protection below) should be cleared of all *kanh* (*Sachharum spontaneum*) *sar* (*S. arundinaceum*) and tree growth, except babul. The regrowth appearing in these strips should be cut by the end of May.

Sowings.—Babul and *kandi* sowings should be done as heretofore. *Preabkalani* sowings should usually be done in all the areas considered suitable for reboisement. When the floods subside sowings should be repeated in areas in which silt may have been deposited during the *abkalani*. Failures should be filled in, after the *abkalani*, by sowings in ploughed lines or dibbles when the ground is wet enough for the seed to germinate.

Kandi seed should, due to the hardy nature of the species, be preferred for sowings in inland forests and in high-lying areas, where incidence of irrigation is scanty and danger from frost considerable. In riverain areas it should be sown in mixture with babul whenever possible, so that in the event of babul being killed by frost, *kandi* can continue to stock the area.

CHAPTER IV

Supplementary Regulations

Thinnings

The felling series have been divided into three blocks each (or two sets of three blocks where the felling series are lengthy) so that every crop should receive silvicultural attention every three years, and thinnings can be carried out when the crops are 3, 6, 9, 15, 21 and 27 years old.

Natural regeneration.—There is every likelihood of natural babul springing up in favourable localities in the gaps caused in the canopy by tree thinnings, from the seed dropped by cattle and by the parent trees. These groups of babul should, as far as possible, be protected from browsers by putting a fence round them or by closing whole compartments to browsing as may be found convenient.

Grazing.—The clear felled areas and other areas under regeneration are closed to grazing for a period of 16 months from June to October and thereby the seedlings get protection from cattle for a period of about 12 months. This provision is adequate and should continue.

Browsing.—In respect to goats and sheep the prescription of the sanctioned working plans is that "all the coupes exploited in the previous ten years, and the coupes in course of exploitation, and other parts containing young growth, such as may be selected by the Divisional Forest Officer, be closed to browsers, the total area so closed in any one year not exceeding one-half of the area of the forest. The half of the area which will be open will be the mature areas least susceptible to injury." The prescription is sound except that the closure of exploited areas for a

period of ten years is probably excessive. All growth over 10′ in height is safe from these animals. Ordinarily babul and *kandi* attain a height of much over 10′ within 5 years after they are established. Allowing three years as the period of establishment, closure of the exploited areas for 8 years should be sufficient.

Fire protection.—A net work of fire lines is necessary to reduce the damage from fires. For this purpose it has been proposed to utilise the existing compartment lines alternately. These lines are 16′ wide. This width should be increased to 66′ by clearing 25′ strips on each side of the line of all *kanh*, *sar* and tree growth except babul. The retention of babul in these strips is advised, because it possesses remarkable power of suppressing grass. It might be even worth while to do babul sowings in parts of those strips where babul does not exist.

If these lines thus widened are kept clear of grass and *kandi* and *lye* coppice, they should form excellent fire lines and provide effective protection against the spread of fires. The clearance of grass and coppice should, as far as possible, be done by cutting or burning twice a year—by the end of January just before the fire season starts and again by the end of May just before the advent of *abkalani*. The clearance in May is prescribed so that the clumps of grass and regrowth of *kandi* and *lye* may be killed by submersion during the immediately succeeding *abkalani*.

In addition, *sar* areas usually found in inland forests and *kanh* areas extensively found in *kachas* near the river should be isolated by fire lines, and should, if there is no or very little babul or *kandi*, be burnt down, and regenerated wherever possible with babul and *kandi*.